COLO

WATER RESOURCE MANAGEMENT PLAN

COLONIAL NATIONAL HISTORICAL PARK

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WATER RESOURCES MANAGEMENT PLAN

COLONIAL NATIONAL HISTORICAL PARK

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WATER RESOURCES MANAGEMENT PLAN

COLONIAL NATIONAL HISTORICAL PARK

Recommended by: _____ 7/12/94
Superintendent, Colonial National Historical Park Date

Approved by: _____ 7/22/94
Regional Director, Mid-Atlantic Date

TABLE OF CONTENTS

EXECUTIVE SUMMARY /vii

CHAPTER 1. INTRODUCTION /1
- Purpose of the Plan /1
- Legislative and Planning Issues /1
- Water Resources Management Objectives /3
- Identification of Water Resource Issues /4

CHAPTER 2. USES, AND REGULATORY RELATIONSHIPS /7
- Land Status and Uses /7
- Regulatory Relationships /7
- Federal Programs, Laws, and Regulations /9
  - National Park Service Organic Act (1916) /9
  - Federal Water Pollution Control Act (Clean Water Act) /9
  - Coastal Zone Management Act /10
  - National Environmental Policy Act /10
  - Floodplain Management (Executive Order 11988) /11
  - Protection of Wetlands (Executive Order 11990) /11
  - National Park Service Management Policies and Guidelines /11
- State and Local Programs /12
  - Virginia Water Quality Standards /12
  - Virginia Wetlands Act /13
  - Virginia Water Protection Permit /14
  - Chesapeake Bay Preservation Act /15
  - Erosion and Sediment Control Law /15
  - Storm Water Management Act /16
- Groundwater Management Act /18

CHAPTER 3. THE HYDROLOGIC ENVIRONMENT /19
- Introduction /19
- Description of the Area /19
- Watersheds and Sub-basin Delineation /21
- Climate /21
- Topography /24
- Stratigraphy /26
- Soils[3] /30
- Surface Water Resources /33
  - Water Quality /33
  - Erosion and Sedimentation /34
  - Floodplains /35
- Groundwater Resources /37
- Water Uses /39
- Status of Water Rights /39
- Underground Storage Tanks /40

External Spills and Leaks /40
External Hazardous Waste Disposal Sites /41
Commonwealth of Virginia Emergency Fuel Storage Facility /41
U.S. Navy Yorktown Fuel Depot /42
U.S. Navy Yorktown Naval Weapons Station (NWS) /42

CHAPTER 4. AQUATIC BIOLOGICAL RESOURCES AND HABITATS /43
Introduction /43
Flora /43
Wetlands /44
Fauna /46
Rare, Threatened and Endangered (RTE) Species /48
Exotic Species /49
Species of Special Interest /49

CHAPTER 5. SUMMARY OF RECOMMENDED WATER RESOURCES MANAGEMENT PROGRAM /52
Introduction /52
Overview of Existing Activities /52
Inventory and Monitoring /55
Research /55
Protection, Management and Mitigation /56
Education and Administration /56

CHAPTER 6. WATER RESOURCES PROJECT STATEMENTS /57
Adjacent Land Use Protection Activities /58
Groundwater Monitoring /61
State Regulatory Process/Permit Review /63
Establishing Land Subsidence/Climate Change Baseline /65
Inventory and Site Assessment of Erosion and Sedimentation Related Problems /66
Development of Geological Maps /68
Shallow Aquifer Delineation /69
Inventory and Monitoring - Springs, Seeps, Streams, and USTs /70
Determination of the Functions & Values of Park Wetland Environments /72
Surface Water Quality Trends Monitoring/Risk Assessment /74
Shoreline Stability/Erosion Monitoring /76

ENVIRONMENTAL COMPLIANCE /78

REVIEW COMMENTS /78

LITERATURE CITED /79

LIST OF PREPARERS /83

ACKNOWLEDGMENTS /84

CONSULTATION AND COORDINATION /85

COPIES DISTRIBUTED FOR REVIEW /87

LIST OF FIGURES

Figure 1. Colonial National Historical Park and Environs /2

Figure 2. Area Map /5

Figure 3. Adjacent Landuse /8

Figure 4. Chesapeake Bay Resource Protection Areas and Resource Management Areas /17

Figure 5. Surface Water Hydrology /22

Figure 6. Sub-basin Drainage Boundaries /23

Figure 7 Geologic Cross Section /25

Figure 8. Aquifers /27

Figure 9. Geology /28

Figure 10. Soils Map /32

Figure 11. Floodplains /36

Figure 12. Vegetation /45

Figure 13. Wetlands /47

Figure 14. RTE/Critical Habitat /51

LIST OF TABLES

Table 1. Colonial NHP Water Resource Issues and Management Concerns /6

Table 2. Virginia Surface Water Standards /12

Table 3. GIS Coverages Developed to Address Water Resource Issues /20

Table 4. Stratigraphy /29

Table 5. Virginia DEQ Water Quality Monitoring Sites in the Vicinity of Colonial NHP /33

Table 6. Natural Heritage Resources in Colonial National Historical Park /50

Table 7. Water Resource Project Statements /53

Table 8. Related Project Statements /53

LIST OF APPENDICES

The following appendices are found in separate documents from the Water Resources Management Plan.

Appendix 1. Adjacent Land Use and Zoning Practices

Appendix 2. Mapping for the Water Resource Management Plan - Development of Hydrologic Coverage, GPS Survey Data, COLO GIS Data Forms

Appendix 3. Selected State and Local Water Resource Related Regulations

EXECUTIVE SUMMARY

Colonial National Historical Park is a 9,327 acre unit of the National Park Service in four counties and two cities in the Coastal Plain of Virginia. It offers a vast array of both cultural and natural resources. This Water Resource Management Plan has been developed as an action plan of the park's Resource Management Plan. It is meant to guide park water resource management initiatives for the next decade.

The park is bordered by two large estuaries, the York River and the James River, which drain into the Chesapeake Bay estuary. A complex network of streams with substantial acreage of salt and freshwater marshes criss-cross park lands. These areas serve as important nursery grounds for juvenile fishes and nesting areas for several avian species found within the Chesapeake Bay. Conservation of these habitats is in part a function of natural processes, best management practices, and good water quality. Colonial National Historical Park shares this responsibility with the neighboring localities; York County, James City County, and the City of Williamsburg, and with the industrial and military complexes along the waterways.

The importance of coordination and consultation with local governments and industry regarding their landuse practices and future expansion plans has been identified in this Plan. The value of current knowledge with respect to federal, state, and local environmental legislation and regulations has also been cited.

Today, and in the future, the park will continue to rely on the power of Geographic Information Systems (GIS) as a means to inventory and monitor the status and changes in resources within the park. A component of this Water Resource Management Plan was committed to expanding and enhancing the existing GIS database for the park. A variety of existing hardcopy mapped information were transferred to digital format. New GIS coverages were generated to strengthen the park's ability to monitor the impacts of natural and anthropogenic stressors to shoreline processes. Landuse maps were created to assist with local coordination efforts, and floodplain maps were developed for future park planning initiatives.

This Plan investigates and identifies water resource related issues where the current level of information is minimal or insufficient to meet the management goals and objectives of the National Park. Project statements for future water-related management actions including inventory, monitoring, research, education, and resource management activities have been proposed and outlined, and will be incorporated into the park's Resource Management Plan.

CHAPTER 1. INTRODUCTION

Purpose of the Plan

This Water Resources Management Plan (WRMP), the first for Colonial National Historical Park (COLO), will serve as the management action plan to guide park water resources-related activities over the next ten years. This WRMP is complementary to, and consistent with, other existing park management documents including the Statement for Management (National Park Service, 1986a), General Management Plan (National Park Service, 1993a), and the Resource Management Plan (National Park Service, 1993b). It will support the National Park Service (NPS) decision making process relating to the protection, preservation, use, enhancement, and management of park water resources and environs.

The WRMP reviews and summarizes available information about the park's water resources and water-dependent environments (e.g., wetlands, York and James rivers, and Chesapeake Bay). Also, it discusses the significant water resource management issues, and provides recommendations for water resources-related management activities including inventory, monitoring, research, and resource management activities. The WRMP will be revised periodically as new issues are recognized, additional information collected, or additional management alternatives identified.

Because of its location in rapidly developing watersheds (and the greater Chesapeake Bay environment), and its unique boundary configuration, successful water resources protection at COLO will require close coordination and cooperation with appropriate state, federal, and local regulators, land-use planning agencies, and researchers. The WRMP strongly encourages such cooperation in identifying, understanding, and resolving water resource issues of mutual interest.

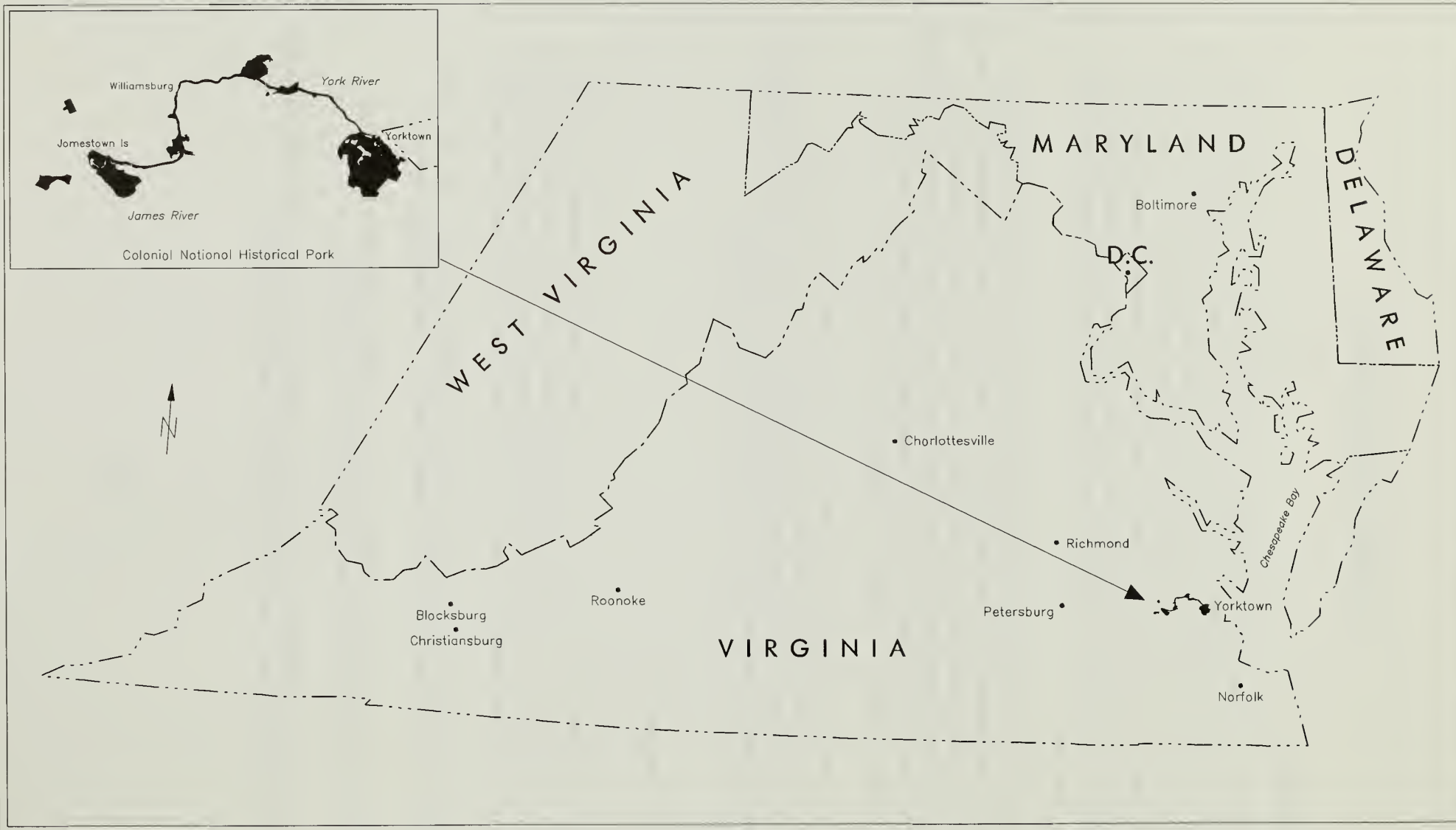
Legislative and Planning Issues

Colonial National Historical Park is a 9,327 acre (3,775 hectares) unit of the National Park System located within the Coastal Plain of Virginia, on the York-James Peninsula between the York River and the James River (Figure 1). The park, established by Public Law 71-510 in 1930, preserves the historic resources of Jamestown Island, the site of the first permanent English settlement in North America, and the Yorktown Battlefield, scene of the culminating battle of the American Revolution.

The park's General Management Plan (National Park Service, 1993a) provides overall management objectives and site specific planning activities. Natural resource related objectives include:

- Protect, enhance, and interpret natural resources in a manner consistent with applicable policies and regulations while supporting cultural resource objectives.

- Actively promote conservation of the landscapes adjacent to Colonial National Historical Park to enhance historic scenic views and to protect park resources and values.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- Cooperate with organizations, individuals, and other agencies to further park objectives and encourage compatible land uses.

- Provide for compatible recreational uses such as walking, jogging, and bicycling when those uses do not conflict with the primary goals of resource protection and interpretation of the historical themes.

- Develop and implement a comprehensive program to inventory, research, and monitor cultural and natural resources.

The park's Resource Management Plan (National Park Service, 1993b) is intended to guide management of cultural and natural resources within the park. This Water Resources Management Plan is an action plan of the park's Resource Management Plan . It identifies specific needs and approaches for the aquatic resources of the park to support the achievement of the overall park management objectives.

Water Resources Management Objectives

Water is a particularly important and sensitive ecosystem component. Its physical availability and quality are critical determinants not only of aquatic resources, but of the park's overall natural resource condition. Water also serves as an important transport mechanism within ecosystems connecting park resources with resources outside park boundaries. Water may deliver pollutants generated by activities outside park boundaries to waters, or conversely, transport pollutants within the park to outside its boundaries.

Because of the important role of water in maintaining resource condition, it is the policy of the NPS to seek to maintain, rehabilitate, and perpetuate the inherent natural integrity of water resources and water-dependent environments occurring within units of the National Park System (National Park Service, 1991). Since water resources are a critical component of a larger ecosystem that spread beyond the park boundaries, the park recognizes the need to cooperate with appropriate local, state, and federal regulators, land-use planning agencies, adjacent land owners, researchers, and the general public in striving to maintain the quality of the water-related resources throughout the watersheds encompassing the park.

The following management objectives have been developed to manage the extensive water-related resources (i.e. wetlands; rare, threatened and endangered (RTE) species; surface water; groundwater; nurseries for fisheries; and shorelines; etc.) of the park and to preserve their highly significant ecosystem function:

- To develop an up-to-date water resources inventory and data base compatible with the park's GIS and database management systems.

- To manage floodplain and wetland resources in a manner that will protect their beneficial attributes and uses.

- To protect rare, threatened, and endangered (RTE) species and their water-dependent habitats.

- To maintain and enhance surface and groundwater quality through both in-park resource management initiatives and cooperative water quality protection activities involving local, state, and federal regulatory and planning agencies.

- To enhance regional water quality protection through full compliance with the Chesapeake Bay Preservation Act regulations.

- To develop an appropriate water resources monitoring program.

- To contribute to the scientific base for water resources management and support and/or coordinate water resources research.

- To promote water conservation through direct NPS action and through cooperation with local communities.

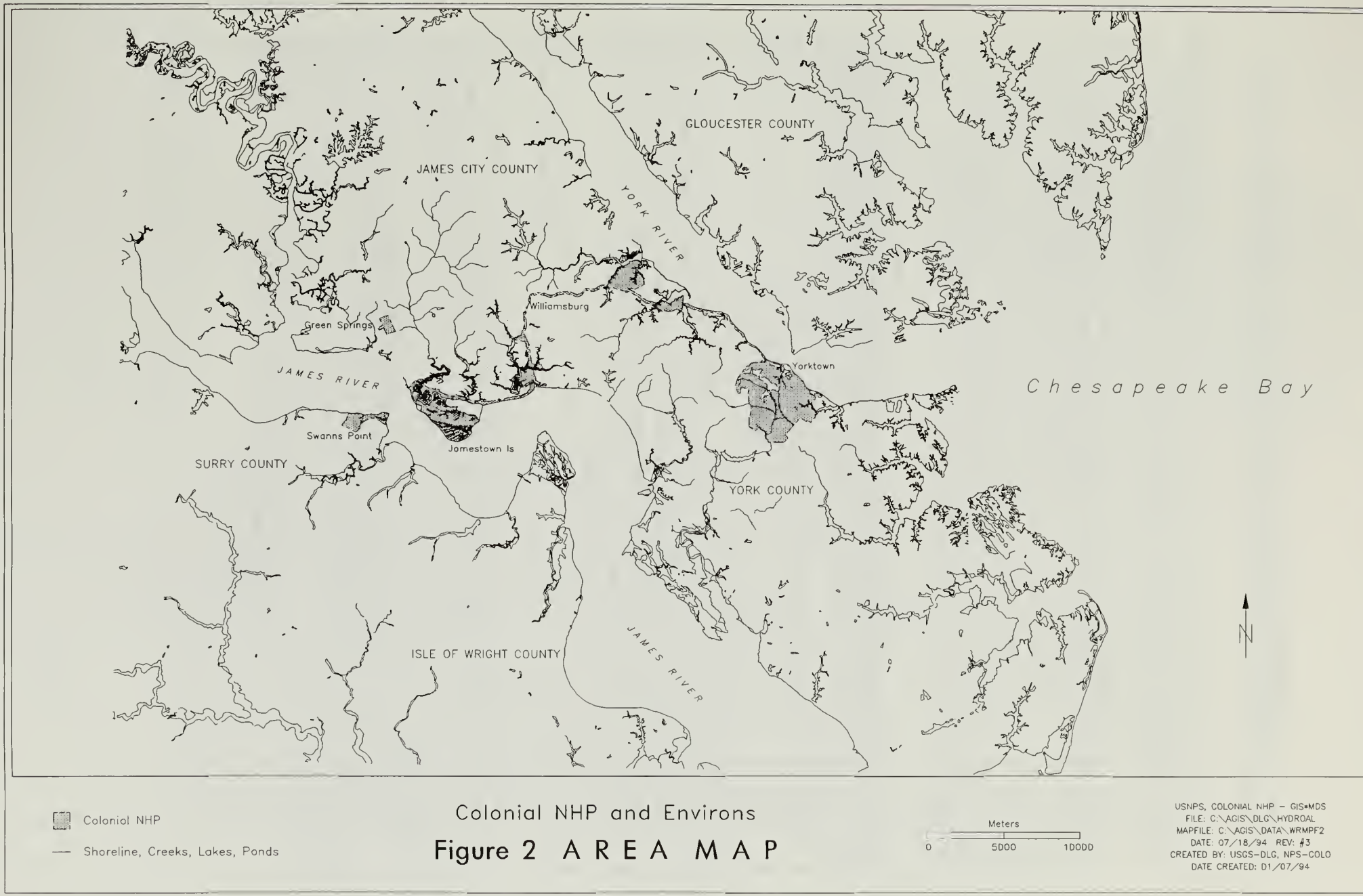
- To promote public awareness of the water resources and water-dependent environments of the park and an understanding of current and potential human impacts upon these resources.

Identification of Water Resource Issues

The unique geographic setting and layout of Colonial National Historical Park means that few of the park's water resources exist within systems wholly contained by the park boundaries. As a result, the overreaching issue for all park water resources is the effective communication and coordination of park management objectives with local, state, and federal entities responsible for the planning, regulation, and management of lands and waters contiguous to the park. In addition, it is important that the park communicates and cooperates with interested environmental constituencies and private parties. The ability of the park to achieve its preservation/conservation and interpretive goals is largely dependent on the impacts of land use and water quality management efforts in surrounding jurisdictions (Figure 2).

An important component of water resources management is developing a more complete understanding of the hydrology and aquatic resources of the park and its surrounding lands. Identification of water resource issues and effective coordination of management efforts to address these issues require a knowledge of both the status and trends of these resources. While much data have been collected in the park and the surrounding areas by a wide variety of programs, there are still significant gaps in the information necessary to adequately describe most of the park's water-related resources. This information will be essential to establishing links between the protection of park resources and activities outside its boundaries. It is this information which will allow park staff to work effectively with managers and regulatory programs whose actions will alter the quality of park water resources. Table 1 lists the primary water resources issues/management concerns facing Colonial National Historical Park.

The need for information on the structure and function of groundwater resources is critical because of potential impacts from adjacent land use practices on park resources. There is some information available on relatively deep aquifers and basic geologic structure of the southeastern portion of Virginia, but the surficial geology and shallow aquifers are poorly understood.



Colonial NHP and Environs

Figure 2 AREA MAP

Inventory and monitoring of the status and changes of surface and groundwater quality within the park is important for protecting both aquatic resources and recreational uses.

Documentation and analysis of shoreline conditions and trends along park rivers, streams, creeks, and drainages is required for the protection of cultural resources, and for developing strategies for the effective management of erosion and sedimentation impacts from within and outside the park.

Evaluation of the structure and function of wetlands within the park is important so that the park can develop strategies for water and vegetation management which will preserve these systems in a manner consistent with park objectives. Tidal and non-tidal wetlands in the park can be affected by local surface water flow management, groundwater withdrawals, and mowing and forestry practices. The wetlands serve as important habitat elements for park biota, especially RTE's and fisheries, and includes some of the critical natural habitats designated by the state's Natural Heritage Program. Wetlands are also a subject of considerable public awareness in eastern Virginia and their management can be subjected to significant scrutiny.

Table 1. Colonial NHP Water Resource Issues and Management Concerns

* GROUNDWATER - Delineate Surficial Geology and Shallow Aquifers - Monitor Groundwater Quality - Inventory Groundwater Withdrawals - Understand External Influences upon Aquifers
* SURFACE WATER - Monitor Flow and Surface Water Quality - Monitor and/or Mitigate Erosion and Sedimentation - Improve Storm Water Management - Evaluate External Influences within Watersheds
* WETLANDS (tidal and non-tidal) - Understand Structure and Function of Wetlands - Protect RTE Species - Comply With Federal and State Regulations for Wetlands Protection - Evaluate External Influences
* SHORELINE - Evaluate Shoreline Stability Impacts to Park Cultural/Natural Resources - Monitor Historic Trends in Shoreline Movement Along the York and James Rivers - Undertake Shoreline Management Strategies
* PARK STEWARDSHIP - Implement Appropriate Inventory and Monitoring of Aquatic Resources - Undertake Appropriate Vegetation Management - Implement Erosion and Sedimentation Control - Assess Non-Point Source Pollution Management - Assure Floodplain Avoidance

Land Status and Uses

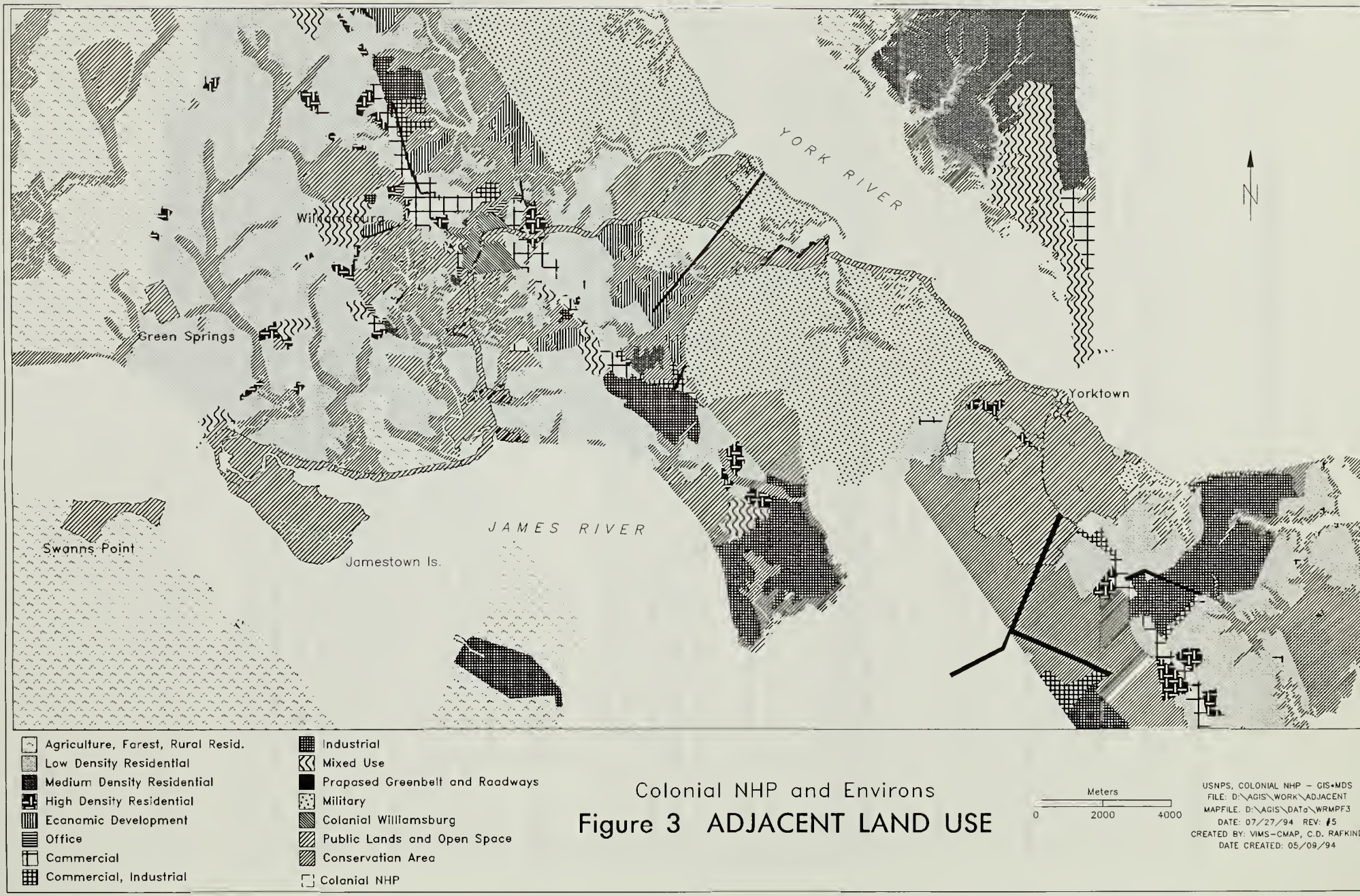
Colonial National Historical Park, occupies the York-James Peninsula between the James and York rivers, in the southeastern Tidewater region of Virginia. The park encompasses most of Jamestown Island\Glasshouse **(1,761 acres/713 hectares)**, Yorktown **(4,301 acres/1,741 hectares)**, and the 23 mile Colonial Parkway and Cheatham (2,689 acres/1089 hectares). The park also includes several detached areas: Green Spring plantation **(195 acres/79 hectares)**, Cape Henry Memorial (.23 acres), Swann's Point **(414 acres/168 hectares)**, and Tindall's Point (1 acre/.4 hectare).

Most of the land of the park is maintained as naturally wooded areas or as open grassed fields. Areas adjacent to the park include extensive land holdings of the U.S. Navy (Naval Weapons Station-Yorktown, Cheatham Annex, Yorktown Fuel Depot), the U.S. Coast Guard Yorktown Reserve Training Center, the City of Newport News Park and watershed, Colonial Williamsburg, College of William and Mary, and residential and commercial development around both Yorktown and the parkway from Williamsburg to the Jamestown area. With the exception of the U.S. Navy. U.S. Coast Guard, and the City of Newport News holdings, much of the area surrounding the park is experiencing increasing levels of development. Agriculture and silviculture, while still present in some portions of the park watersheds, are of declining significance. Single family and multi-family residential and commercial development is increasingly prevalent on lands within park watersheds, particularly in the western reaches around Williamsburg (Figure 3).

Colonial National Historical Park comprises only a small percentage of the land area within the York River and James River watersheds. Only Wormley Pond, an unnamed creek in the vicinity of Washington's Headquarters, and Passamore Creek arise within the park. Landuse activity along waters outside the park affect aquatic resources and quality within COLO. Appendix 1 contains a review of the landuse plans and strategies applicable to most of the lands adjacent to the park.

Regulatory Relationships

A variety of federal, state and local regulatory programs which pertain to the protection and management of water-related resources in and adjacent to the park. The principal federal programs are established under the Clean Water Act, the Coastal Zone Management Act and the National Environmental Policy Act. In recent years, Virginia has added or enhanced a number of regulatory programs aimed at protecting and improving water resources in the Commonwealth. Many of the state programs are administered at the local government level (see Appendix 3). These programs, created through enabling state legislation may provide a state level program, regulations, and oversight. None of these regulatory programs appear to establish any conflicts with park management objectives. However, given the nature of the hydrologic resources of the park and the importance of activities outside park boundaries on water resource quality within the park, full knowledge of and coordination with these programs and their implementing agencies is crucial.



Colonial NHP and Environs

Figure 3 ADJACENT LAND USE

Federal Programs, Laws, and Regulations

National Park Service Organic Act (1916)

The Organic Act specifies that the National Park Service (NPS) is responsible for the preservation and conservation of natural resources in all park lands under its jurisdiction. This act was reinforced by Congress in 1970 with legislation stating that all park lands are united by a common preservation purpose, regardless of title or designation. Hence, all water resources in the National Park System are protected equally by Federal Law, and it is the fundamental duty of the NPS to protect those resources unless otherwise indicated by Congress.

Federal Water Pollution Control Act (Clean Water Act)

The Federal Water Pollution Control Act, more commonly known as the Clean Water Act, was first promulgated in 1972 and amended in 1977, 1987, and 1990. This law was designed to restore and maintain the integrity of the nation's water. Goals set by the act were swimmable and fishable waters by 1983 and no further discharge of pollutants into the nation's waterways by 1985. The two strategies for achieving these goals were a major grant program to assist in the construction of municipal sewage treatment facilities and a program of "effluent limitations" designed to limit the amount of pollutants that could be discharged.

As part of the Act, Congress recognized the primary role of the states in managing and regulating the nation's water quality within the general framework developed by Congress. All federal agencies must comply with the requirements of state law for water quality management, regardless of other jurisdictional status or land ownership. States implement the protection of water quality under the authority granted by the Clean Water Act through best management practices and through water quality standards. Best management practices are defined by the U.S. Environmental Protection Agency as methods, measures or practices selected by an agency to meet its nonpoint control needs. These practices include but are not limited to structural and non-structural controls and operations and maintenance procedures. They can be applied before, during and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters. Water quality standards are composed of the designated use or uses made of a water body or segment, water quality criteria necessary to protect those uses, and an anti-degradation provision which may protect the existing water quality.

Section 404 of the Clean Water Act further requires that a permit be issued for discharge of dredged or fill materials in waters of the United States including wetlands. The Army Corps of Engineers administers the Section 404 permit program with oversight and veto powers held by the Environmental Protection Agency. Several field offices of the U.S. Corps of Engineers administer the Section 404 permit program throughout Tidewater Virginia. The Environmental Protection Agency, the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) provide advice on the environmental impacts of proposed projects.

Section 402 of the act requires that a National Pollutant Discharge Elimination System (NPDES) permit be obtained for the discharge of pollutants from any point source into the waters of the Untied

States. Point source, waters of the United States and pollutants are all broadly defined under the Act, but generally all discharges and storm water runoff from major industrial and transportation activities, municipalities, and certain construction activities must be permitted by the NPDES program. The State of Virginia has been delegated NPDES permitting authority by the Environmental Protection Agency. The State, through the permitting process, establishes the effluent limitations and monitoring requirements for the types and quantities of pollutants that may be discharged into its waters. Under the antidegradation policy, the state must also insure that the approval of any NPDES permit will not eliminate or otherwise impair any designated uses of the receiving waters.

Coastal Zone Management Act

The federal Coastal Zone Management Act (henceforth referred to as the Act) was passed in 1972 in order to provide assistance and encouragement to coastal states in the effective protection and careful development of the coastal zone. The Act established a grant-in-aid program currently administered by the Office of Ocean and Coastal Resource Management of the National Oceanic and Atmospheric Administration.

The Virginia Coastal Resource Management Program was approved in 1986. The program is administered by Virginia Department of Environmental Quality (DEQ). The program is a network of several resource management activities administered by various state agencies. The wetlands management program is one component of Virginia's program.

Section 301 of the Act is a provision known as the consistency clause. The intent of the provision is to ensure that federal activities, Outer Continental Shelf Plans and federal assistance to states and local governments are consistent with the state's federally approved coastal resources management program. Under the consistency clause, a state may prevent a federal proposed action if it is found to be inconsistent with the state program.

The DEQ is the lead agency for reviewing and responding to all federal consistency determinations. Some of the many categories of federal activities subject to review under Virginia's coastal program are; dredging, channel work, dams, location and acquisition of defense and coast guard installations, and acquisition and master plans of national parks and seashores.

National Environmental Policy Act

Congress passed the National Environmental Policy Act (NEPA) in 1969. NEPA established a general federal policy for the responsibility of each generation as trustee of the environment for succeeding generations. Specifically, NEPA requires that an environmental impact statement (EIS) be prepared as part of the review and approval process by federal government agencies of major actions which significantly affect the quality of human life. The primary purpose of an EIS is to serve as an action-forcing device to ensure evaluation of the impacts of proposed projects and facilitate public review.

An environmental assessment may be prepared prior to initiating an EIS. The assessment is used to make a determination if the preparation of an EIS is required. An EIS is not prepared when the review of an environmental assessment results in the "Finding of No Significant Impact (FONSI)"

Implementing regulations require the cooperation of federal agencies in the NEPA process. The regulations also encourage the reduction of duplication through cooperation with state and local

agencies including early efforts of joint planning, joint hearings and joint environmental assessments. The Virginia Department of Environmental Quality coordinates the review of environmental assessments for projects in Virginia.

Floodplain Management (Executive Order 11988)

Executive Order 11988 entitled "Floodplain Management" requires all federal agencies to "reduce the risk of flood loss, ... minimize the impacts of floods on human safety, health and welfare, and ... restore and preserve the natural and beneficial values served by floodplains" (Goldfarb, 1988). Federal agencies are therefore required to implement floodplain planning and consider all feasible alternatives which minimize impacts prior to construction of facilities or structures. Construction of such facilities must be consistent with federal flood insurance and floodplain management programs. West (1990) suggests that park service managers should ensure that where park resources fall within flood hazard areas, these areas are properly marked to increase public awareness of potential flood dangers at the site. To the extent possible, park facilities such as campgrounds and rest areas should be located outside these areas. National Park Service guidance pertaining to Executive Order 11988 can be found in Floodplain Management Guidelines (National Park Service, 1993c).

Protection of Wetlands (Executive Order 11990)

Executive Order 11990, entitled "Protection of Wetlands", requires all federal agencies to "minimize the destruction, loss or degradation of wetlands, and preserve and enhance the natural and beneficial values of wetlands" (Goldfarb, 1988). Unless no practical alternatives exists, federal agencies must avoid activities in wetlands which have the potential for adversely affecting the integrity of the ecosystem . National Park Service guidance for compliance with Executive Order 11990 can be found Floodplain Management and Wetland Protection Guidelines, published in the *Federal Register* (45 FR 35916, Section 9). The Wetland Regulatory Compliance: A Guidance Manual for the National Park Service Mid-Atlantic Region (National Park Service, 1989) should also be consulted for issues pertaining to wetlands.

National Park Service Management Policies and Guidelines

The management of the national park system and NPS programs is guided by the Constitution, public laws, proclamations, executive orders, rules and regulations, and directives of the Secretary of the Interior and the Assistant Secretary for Fish and Wildlife and Parks. Servicewide policy is articulated by the Director of the National Park Service, and must be consistent with the above laws, regulations etc. The NPS *Management Policies* (National Park Service, 1988) provide broad policy guidance for planning, land protection, natural and cultural resource management, wilderness preservation and management, interpretation and education, special uses of the parks, park facilities design, and concessions management.

Recommended procedures for implementing servicewide policy are described in the NPS guideline series. The guidelines most directly pertaining to actions affecting water resources include: 1) NPS-2, which provides guidelines for the planning process (National Park Service, 1982a); NPS-12, which addresses compliance with the National Environmental Protection Act including preparation of EIS's, EA's, and categorical exclusions (National Park Service, 1982b); 3) NPS-75, which provides natural

resources inventory and monitoring requirements (National Park Service, 1992); and 4) NPS-77, which guides natural resource management activities (National Park Service, 1991).

State and Local Programs

Appendix 3 provides a review of the various State and local regulatory programs and legislation pertinent to water resources. It includes: Virginia State Water Control Board; Virginia Water Protection Permit regulations; the Chesapeake Bay Local Assistance Board Final Regulations for the Chesapeake Bay Preservation Act; the local Chesapeake Bay Preservation ordinances for James City County, Williamsburg and York County; Virginia Soil and Water Conservation Board Erosion and Sediment Control Regulations; the erosion and sediment control ordinances for James City County, Williamsburg and York County; and Virginia Department of Conservation and Recreation Storm Water Management Regulations.

Virginia Water Quality Standards

The purpose of this statute is to maintain the quality of the waters of the Commonwealth of Virginia "... at such a quality that will protect all existing, beneficial uses attained on or after November 28, 1975 and will support the propagation and growth of all aquatic life, including game fish, which might reasonably be expected to inhabit them. Existing beneficial uses include, but are not limited to, recreational uses, e.g. swimming and boating; and production of edible and marketable natural resources, e.g. fish and shellfish." (VR680-21-01.2)

In order to achieve the above objective, the Virginia Surface Water Standards promulgate water quality criteria to support the existing beneficial uses. Within Colonial National Historical Park waters are designated as either Class II (Estuarine Waters) or Class III (Non-tidal Coastal and Piedmont Zone Waters). Water quality criteria for dissolved oxygen, pH, and water temperature pertaining to these designations are outlined in Table 2.

Table 2. Virginia Surface Water Standards

CLASS	Dissolve Oxygen Minimum (mg/L)	Dissolved Oxygen Daily Mean (mg/L)	pH	Temperature (MAX) C°
II	4.0	5.0	6-9	N/A
III	4.0	5.0	6-9	32

Additional criteria have also been established for substances potentially toxic to aquatic life or of public health significance including ammonia, chloride, arsenic, cyanide, cadmium, copper, chromium, total residual chlorine, aldrin, anthracene, benzene, benzo(a)anthracene, benzo(b)fluoranthene,, benzo(k)fluoranthene, benzo(a)pyrene, bromoform, carbon tetrachloride, chlordane, chlorodibromomethane, chloroform, chloromethane, chloropyrifos, chrysene, DDT, demeton, dibenz(a,h)anthracene, dichloromethane, dichlorobenzene, dichlorobromomethane, dichloroethane, tributyltin (TBT), and fecal coliform bacteria (VR680-21-01.14).

Special water quality criteria pertain to shellfish waters of the York River and James River estuaries (fecal coliform bacteria) (VR680-21-02.1) and Jones Mill Pond which is utilized as a water supply for Cheatham Annex.

In addition to designation of beneficial use and promulgation of appropriate water quality criteria, the US Environmental Protection Agency also requires that all states establish as part of their water quality standards a regulatory doctrine which includes antidegradation policy for various levels of water quality. Statutory and regulatory basis for this requirement is outlined in section 303(C)(4) of the Clean Water Act and EPA's water quality standards (40CFR131.32). The antidegradation policy is expected to be modeled after EPA's three tiered approach for maintaining and protecting water quality.

In May, 1992 the Department of Environmental Quality (DEQ) adopted amendments to the State's water quality standards which allow for the designation of exceptional waters (VR 680-21-01.3.C), defined as those waters which provide exceptional environmental settings, valuable aquatic communities or recreational opportunities. This regulation gives the authority to the Department of Environmental Quality to designate certain waters as exceptional only after finding that the nominated water body meets the outlined criteria.

Any public or private individual or conglomerate can nominate a waterway for inclusion on the list of designated waters (VR 680-21-01.3.C.3) in accordance with the Administrative Process Act and the DEQ's Public Participation Guidelines. The nomination is reviewed by DEQ to determine if the nominee meets the required criteria. If so, DEQ will notify all parties potentially impacted by the designation. This includes notification to local governments with interests in these waters. A public hearing is scheduled for all interested parties.

Waterways officially designated as exceptional become protected against further degradation. No new VPDES permits will be awarded, and no new point sources or expansion to existing point sources are permitted. Temporary and limited pollution effects may be authorized by DEQ and these cases are addressed individually.

Presently, no waters have officially been designated as exceptional under the regulations. The first public hearing scheduled will address five nominations. None of the nominated waters are within or adjacent to Colonial National Historical Park.

Virginia Wetlands Act

The Commonwealth of Virginia adopted the Virginia Wetlands Act in 1972 (VA Code Sec. 28.2-1300). The purview of the Virginia Wetlands Act is confined to a geographic area defined in the text as Tidewater Virginia and applies only to tidal wetlands. The legislation requires a permit for activities in tidal wetlands. Certain activities are specifically excluded from the permit requirement including: noncommercial piers, fences, and catwalks, cultivation of shellfish, agriculture, forestry, normal road maintenance, and outdoor recreation.

The Virginia Wetlands Act provides for the establishment of local Wetlands Boards by counties, cities or towns within Tidewater and includes a model wetland ordinance for adoption by the localities. If a town within a county or city does not establish a Wetlands Board, the county or city will process permit applications for that town.

The Virginia Marine Resources Commission (VMRC) has oversight at the state level and hears appeals of decisions made at the local level. The Commission also serves as the local Wetlands Board for localities which have not established their own. There are 35 local Wetlands Boards, including two boards established by towns.

Originally wetlands were defined under the Virginia Wetlands Act to be those lands contiguous to tidal waters within one and one half times the mean tide range and vegetated with wetlands plants listed in the legislation. However, the vegetation requirement excluded non-vegetated wetland resources and these wetlands were added by definition in 1982.

The Wetlands Guidelines, prepared by the Virginia Institute of Marine Science and the Virginia Marine Resources Commission (VMRC) (Commonwealth of Virginia, 1982), were developed in order to implement the legislation and assist the localities. The guidelines provide information on the functions and values of wetlands community types and assign the types to ranked groups. The guidelines contain a section on evaluating alterations of wetlands which includes specific criteria and the environmental rationale.

The VMRC serves as a clearing house for the processing of applications for activities affecting wetlands and waters in Virginia. A single application (referred to as a joint permit application) may be submitted to the VMRC for distribution to the proper local, state and federal permitting and reviewing agencies.

James City County, York County, Gloucester County, and the City of Williamsburg all have established local Wetlands Boards. In 1992, Surry County established its Wetlands Board.

Virginia Water Protection Permit

The federal Clean Water Act (CWA) includes a provision in section 401 of the Act for states to administer a certification program in conjunction with the Army Corp of Engineers section 404 permit review process. The state program is administered by the Department of Environmental Quality. In 1989, the Virginia General Assembly passed legislation creating the Virginia Water Protection Permit (VA Code Sec. 62.1-44.15:). The issuance of the permit constitutes the certification required under section 401 of the CWA.

Before a permit may be issued, a determination that the activity is consistent with the provisions of the CWA and protects instream beneficial uses must be made. Beneficial uses are defined as navigation, waste assimilation, fish and wildlife resources and habitat, recreation, cultural, and aesthetic values.

The State Water Control Board adopted regulations to implement the Water Protection Permit program in 1992 (VR 680-15-02). Regulations require a permit be issued for activities which result in discharge to surface waters. Surface waters are waters subject to the ebb and flow of the tide and waters used in interstate commerce including wetlands. Exemptions from permit requirements are specified in the regulations and include activities such as: placement of navigation aids, fish and wildlife harvesting devices, noncommercial mooring buoys, survey activities, and normal farming and silviculture.

The regulations require additional information to the joint permit application in order to process a water protection permit. Information required includes: stream classification according to state water

quality standards, drainage area, and hydrologic unit code. A functional assessment of the affected surface waters including an assessment of impacts to existing instream beneficial uses and proposed beneficial uses of the impacted waters is also required.

Chesapeake Bay Preservation Act

In 1988, Virginia passed the Chesapeake Bay Preservation Act. The act empowered localities to consider water quality issues when making land use decisions. Further, the act required all Tidewater localities to develop and adopt local programs and map sensitive areas. The program is administered by the Chesapeake Bay Local Assistance Board (CBLAB). CBLAB has the responsibility of assessing the consistency of proposed local programs with state regulations. The regulations define Resource Protection Area (RPAs) and Resource Management Area (RMAs) and provide guidelines on the determination of these areas and the management tools applicable to regulating land use in the RPAs and RMAs.

Resource Protection Areas (RPAs) are those natural areas most sensitive to disturbance; activities in these areas may lead directly to impacts on water quality. The RPA designation includes: tidal wetlands, nontidal wetlands connected by surface flow and contiguous to tidal wetlands or tributary streams, tidal shores, other lands at local discretion, and buffered areas not less than 100 feet in width landward of all other components of RPAs and along both sides of any tributary stream. There is greater latitude given the localities in the designation of RMAs; however, the regulations suggest the consideration of designating the following: nontidal wetlands (other than those specified as RPAs), floodplains, highly erodible soils, highly permeable soils, and other lands at local discretion.

The regulations promulgated by the Chesapeake Bay Local Assistance Board also include performance criteria for land use and development. The performance criteria address such issues as land clearing, erosion and sediment control, septic systems, storm water management, and best management practices (BMPs). The Chesapeake Bay Local Assistance Board provided the Local Assistance Manual (Commonwealth of Virginia, 1989a) to localities to assist in the interpretation and application of the performance standards.

The local programs of York County, James City County and the City of Williamsburg have all been found consistent with the state regulations. James City County has designated the entire county, aside from the RPAs, as an RMA (Figure 4).

Erosion and Sediment Control Law

The Commonwealth adopted the Erosion and Sediment Control Law in 1973. Subsequent amendments have provided greater strength to the law, including enabling legislation to allow localities to enforce programs through civil penalties as an alternative to criminal procedures (Article 4 of Chapter 5 of Title 10.1, Code of Virginia). The law requires an approved erosion and sediment control plan prior to any land-disturbing activity. Exemptions are given for mining, oil and gas exploration and drilling, most agricultural activities, and certain activities involving minor land disturbance. The Soil and Water Conservation Board is responsible for promulgating regulations for the state program administered by the Department of Conservation and Recreation, Division of Soil and Water Conservation.

The law requires each program authority, which could include a Soil and Water Conservation District (SWCD), county, city, or town in the Commonwealth to have a program consistent with the state program and regulations. Provisions are made in the law for localities to adopt and administer an approved local program. There are 170 local programs in Virginia covering every county, city and town. The 1993 amendments allow for programs not properly administered by the locality, to be administered by the SWCD or the citizens board - Soil and Water Conservation Board. The 1993 amendments further require erosion and sediment control plans to be reviewed by a Soil and Water Conservation Board certified plan reviewer. The Soil and Water Conservation District can be involved in plan review of local programs, and assistance is offered through inspections, public education, and advisory programs. Minimum standards for local programs listed in the new regulations address many issues including: permanent soil stabilization, vegetative cover, need for sediment basins, work in active watercourses and sediment deposition, and erosion and damage downstream due to increases in runoff volume and velocity (Virginia Regulations 625-02-00 Section 1.5).

The Virginia Erosion and Sediment Control Handbook (Commonwealth of Virginia, 1992) provides localities the information necessary to develop programs consistent with state regulations. The 1992 edition reflects the recent revisions and amendments adopted during the 1993 General Assembly session. The handbook includes general criteria which are minimum state requirements for controlling erosion and sedimentation from land disturbing activities. Design criteria and construction specifications with photographs from the field are given for a range of erosion and sediment control devices.

The majority of the National Park Service property is in the Colonial Soil and Water Conservation District which includes James City County, York County and the City of Williamsburg. Surry County is located within the Peanut Soil and Water Conservation District.

Storm Water Management Act

In an effort to further inhibit the deterioration of state waters and reduce nonpoint source pollution, localized flooding, and stream erosion, the General Assembly passed the Storm Water Management Act in 1989 (Article 1.1, Chapter 6, Title 10.1 Code of Virginia). The law is administered by the Department of Conservation and Recreation, Division of Soil and Water Conservation. As with other natural resources legislation, this act enables the development of storm water management programs at the local level. Exemptions are made for mining, oil and gas exploration, and single family residences not part of subdivisions. Regulations were promulgated in 1990 to implement the act (Virginia Regulations 215-02-00).

The technical criteria are found in Part 2 of the regulations. General provisions within the requirements include: 1) a storm water management plan for which the post-development peak runoff from both a two-year and 10-year span does not exceed pre-development rates; 2) design storms shall be either 24-hour with rainfall recommended by the U.S. Soil Conservation Service or that which produces the greatest required storage at the site; and 3) new construction should be avoided in floodplains. The regulations include procedures for localities to submit programs for a determination of consistency with the state program and encourage regional storm water

Colonial NHP and Environs

Figure 4 CHESAPEAKE BAY PRESERVATION AREAS

management planning for watershed areas. If requested by a locality, the department will review a plan with real or potential inter-jurisdictional impacts and report to the locality. York and James City counties are currently working on the development of a local storm water management program.

Groundwater Management Act

The Virginia Department of Environmental Quality (DEQ) administers the Groundwater Management Act of 1992 (Chapter 25 of Title 62.1 Code of Virginia). Groundwater withdrawals of less than 300,000 gallons per month are not subject to regulation under the Groundwater Management Act. Groundwater areas of the Commonwealth have been described by geographical location. A groundwater area study to determine the need to establish a groundwater management area may be initiated by the DEQ or by petition. The DEQ may establish a groundwater management area if there is reason to believe that: 1) groundwater levels in the area are declining or have declined excessively; or 2) the wells of two or more users interfere substantially with one another; or 3) the available groundwater supply is being or is about to be overdrawn; or 4) the groundwater has been or may be expected to become polluted.

After the establishment of a groundwater management area, a permit from the Department of Environmental Quality is required for withdrawals or enlargement of withdrawals of groundwater. Historically, under the Groundwater Act of 1973, a user could obtain the rights to groundwater withdrawals in excess of actual use. The Groundwater Management Act of 1992 requires existing groundwater users to obtain new permits based on actual use.

CHAPTER 3. THE HYDROLOGIC ENVIRONMENT

Introduction

This section reviews the hydrologic setting of the park. Particular attention is paid to information sources and gaps. Much of the park's concern in water resources will be focused on maintaining hydrologic systems capable of supporting the natural resources of the park. The elongated shape of the park, bisecting the lower Peninsula and two major watersheds, makes the comprehensive understanding of the surface and groundwater systems of the park complex. A significant amount of additional work will be necessary to develop a useful understanding of the interrelated hydrology of the park and its environs. This understanding is needed to coordinate with local, state, and federal planning and regulatory programs affecting park and adjacent lands in order to meet park management objectives.

A review of the current literature related to the water resource issues (Table 1) identified in the previous section was conducted. Local, state, and federal agencies were approached for information concerning the availability of water quality, groundwater, and geologic data (see Consultation and Coordination, p.83). The lack of basic information, and/or the lack of consistency between data sources was documented.

To expand the park's Geographic Information System (GIS) database, several new digital coverages were developed. The limited basic data pertaining to water resources provided direction for determining which new digital spatial information was critical to the tasks and objectives in the WRMP proposal. Table 3 identifies the new GIS coverages generated as part of the development of the WRMP. Details regarding the development, and attributes, of the different GIS coverages are found in a separate Appendix 2. The park supplied GIS coverages dealing with vegetation, wetlands, hydrology, park boundaries, and soils for review, use, and updates, as necessary.

A large-scale effort to map the present day shoreline position was conducted to assist the park in addressing present and future shoreline management issues . This included a large network of survey points collected using a Global Positioning System (GPS). These points serve as rectification points for the vertical imagery used in the shoreline mapping. A detailed discussion of the methods used to produce this shoreline survey is presented in Appendix 2.

Description of the Area

Colonial National Historical Park lies within the boundaries of the counties of York, James City, Gloucester, and Surry, and the City of Williamsburg. Cape Henry is a small distinct unit in the City of Virginia Beach. The park lies within the coastal plain of Tidewater Virginia with all of the park lands having a direct hydrological link to the Chesapeake Bay. Most of the park extends along either the York or James rivers, two of the largest rivers contiguous to the western shore of the Chesapeake Bay. In addition, numerous streams, creeks and ponds flow through the park and feed directly into one of these two rivers. Mixed pine and hardwood forests cover most of the park, but substantial acreage of both tidal and nontidal wetlands and open fields also exist.

Table 3. GIS Coverages Developed to Address Water Resource Issues

GIS COVERAGE	DATA SOURCE	SCALE	DATE
100 Year Floodplain	Federal Emergency Management Agency (FEMA)	1:24,000	1988
Proposed Adjacent Landuse	James City County - Comprehensive Plan City of Williamsburg - Comprehensive Plan York County - Comprehensive Plan	1:24,000	1991 1989 1991
Surface Geology	USGS - Mixon, et al., 1989	1:250,000	1989
Well Sites In and Around COLO	Virginia Department of Environmental Quality U.S.G.S Water Resources Division James City County York County City of Williamsburg	1:24,000	various
Resource Management and Resource Protection Areas	James City County - Comprehensive Plan City of Williamsburg - Comprehensive Plan York County - Comprehensive Plan	1:24,000	1991 1989 1991
Watershed Boundaries	USGS Topographic Maps	1:24,000	various
GPS Photo Control Points	VIMS	1:12,000	1992
High Resolution Shoreline	Virginia Marine Resources Commission	1:5,000	1976
Low Resolution Shoreline	USGS Topographic Maps	1:24,000	various
Primary and Secondary Shoreline - Present Day	Virginia Department of Transportation	1:12,000	1990

Watersheds and Sub-basin Delineation

More than 33 miles of shoreline along the James and York rivers bounds the park. In addition, 24.4 miles of perennial streams and 30.9 miles of intermittent streams and drainages flow through the park (Figure 5). A drainage divide on the peninsula marks the division between the drainage into the York River watershed in the north and James and Chickahominy watershed in the south (Figure 6). This drainage divide line (watershed boundary) roughly corresponds to the route of old U.S. 60.

The James River watershed is considered one of the most important watersheds within the Commonwealth of Virginia. Its headwaters in central-western Virginia are located nearly 450 miles from its confluence with the Chesapeake Bay. The watershed covers 10,102 square miles, or just slightly more than 25 percent of the total surface area of the state. Approximately 33 percent of the population live within the watershed and utilize the resources for social and/or economic purposes (Commonwealth of Virginia, 1990a)

The York River watershed is situated between the James River Basin to the south, and the and the Rappahannock River Basin to the north. The entire watershed lies within the Piedmont and Coastal Plain of the state. Total drainage area for the watershed is 2,661 square miles. Development within the basin is limited, with nearly 70 percent of the watershed forested and 22 percent of the watershed in agricultural or pastoral land uses. Less than 2 percent of the area is urbanized (Commonwealth of Virginia, 1990a).

Numerous freshwater tributaries, in Yorktown, flow through park lands. As they approach the James and York rivers these tributaries become tidally influenced, estuarine waters. Surface waters in the vicinity of Yorktown include Wormley Pond, Great Run, Baptist Run, Beaver Dam Creek, Yorktown Creek, and Ballard Creek. Surface water features on Jamestown Island include Sandy Bay, Back River, Kingsmill Creek, Passmore Creek, and the Thorofare. The Colonial Parkway passes among upland and tidal streams, as well as freshwater and brackish ponds. Surface water features along the Colonial Parkway include Ballard Creek, Roosevelt Pond, Brackens Pond, Indian Field Creek, Felgate's Creek, King's Creek, Queen's Creek, Cheatham Pond, Jones Mill Pond, Halfway Creek, College Creek, Papermill Creek, and Powhatan Creek. A freshwater spring and a small creek are on Green Spring plantation, and a series of springs originate on the Yorktown Battlefield. Numerous ephemeral ponded sinkholes occur on the Yorktown Battlefield and along the Parkway.

Climate

Tidewater Virginia has a warm temperate climate, which contributes to the park's popularity with tourists. Average winter daytime temperatures peak at 10 C (50 F) with night time lows of -3 C (25 - 30 F). Summer temperatures are also mild ranging from daytime highs of 30 C (85 - 90 F) down to 20 C (60 F) at night. The area is generally rather humid, especially during the summer months. Average relative humidity year round for mid-afternoon is 60%. Humidity is much higher in the mornings with relative humidity at dawn around 80%. Rainfall throughout the year remains relatively constant. Fifty percent of the annual total precipitation falls between the months of April and September. July and August are the wettest months; October, November and April are the driest. Average rainfall per month varies between three and five inches. The average yearly total is about 45 inches.

Colonial NHP

Shoreline, Creeks, Lakes, Ponds

Colonial NHP and Environs

Figure 5 SURFACE HYDROLOGY

Meters

0 2000 4000

USNPS, COLONIAL NHP – GIS•MDS
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MAPFILE: C:\AGIS\DATA\WRMPF5
DATE: 07/19/94 REV: #3
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USGS–DLG, NPS–COLO
DATE CREATED: 01/11/94

Colonial NHP

Sub-basin Drainages

Shoreline, Creeks, Lakes, Ponds

Colonial NHP and Environs

Figure 6 SUB-BASIN DRAINAGES

Meters

0 2000 4000

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MAPFILE: C:\AGIS\DATA\WRMPF6
DATE: 07/19/94 REV: #4
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DATE CREATED: 01/13/94

Topography [1]

The park is situated in the York-James Peninsula. Lands within the park have a varying topography which takes in both low-lying wetlands and ravines, and terraces up to 120 feet (38 meters) above mean sea level (MSL) (Figure 7). The Jamestown Island/Glasshouse and Green Spring are the flattest of all the park holdings; being generally at sea level broken by a few gentle slopes. The area around Yorktown is also of a gently sloping nature, but some deep ravines do exist. The Colonial Parkway and Cheatham Pond rise from sea level to hills of 50 feet (15 meters) above MSL in elevation. The nearly flat Swann's Point are broken in some places by steep slopes rising to more than 100 feet (30 meters) above MSL.

Topographically, Jamestown Island is comprised of a central upland flanked on the south by a ridge and swale (trough) landscape and by Back River marsh on the north. Back River marsh is a brackish tidal marsh. The central upland trends east-west, has a partially flooded low relief ridge and swale topography, and reaches a maximum elevation of about 15 feet above sea level. The southern ridge and swale is drained by Passmore Creek and its tributaries. The ridges trend east-west to northwest-southwest and are connected by the northwest-southeast trending Goose Hill Ridge, a modern beach-dune complex. The swales are occupied by tidal salt marshes. All marshes and lower elevations less than 5 feet above sea level are flooded periodically by tropical storms and northeasters.

The Green Springs unit of the park crosses three terraces separated by two scarps. The northern part lies between 60 and 75 feet above sea level and is part of the Lackey Plain. The Kingsmill scarp separates the higher lands from the Huntington flat (40 to 50 feet MSL) on the southwest. The Todds flat at about 20 feet MSL extends northeast-southwest across the southeastern part of Green Springs. Intermittent streams drain the property to the southwest and east.

The topography of the York-James Peninsula across which the Colonial Parkway extends is characterized by a series of flats and risers (scarp) forming a stair-stepped or terraced landscape. The flats increase in elevation and antiquity away from the James and York Rivers and represent the emergent bottoms of former James and York rivers and the Chesapeake Bay. The higher, dissected terraces have 60 to 80 feet of local relief. Most stream valleys have steep walls and flat floors with meandering stream channels. The floors of the valleys are covered by alluvium and marsh and swamp deposits.

Numerous sinkholes occur in the Yorktown Battlefield, and along the Parkway between Yorktown and College Creek. The largest known sinkhole on parklands is located northeast of the intersection of U.S. 17 and the Parkway at Yorktown.

The Parkway between Powhatan Creek and College Creek crosses low terraces which are subparallel to the James River. The terraces, which are less than 15 feet above sea level, are surmounted by straight to curved low east-west trending ridges. Relief between ridges and troughs is usually about 5 to 10 feet. Much of this section of the Parkway is built on fill rather than native material. Near College Creek, the parkway curves northeastward on a recurved spit.

Between College Creek and Halfway Creek the Parkway steps onto a terrace (Huntington flat) about 40 to 45 feet above sea level. The nearly flat surface is interrupted by shallow sinkholes about 3 to 5 feet deep and 75 to 150 feet wide. The terrain between Halfway Creek and Williamsburg increases in

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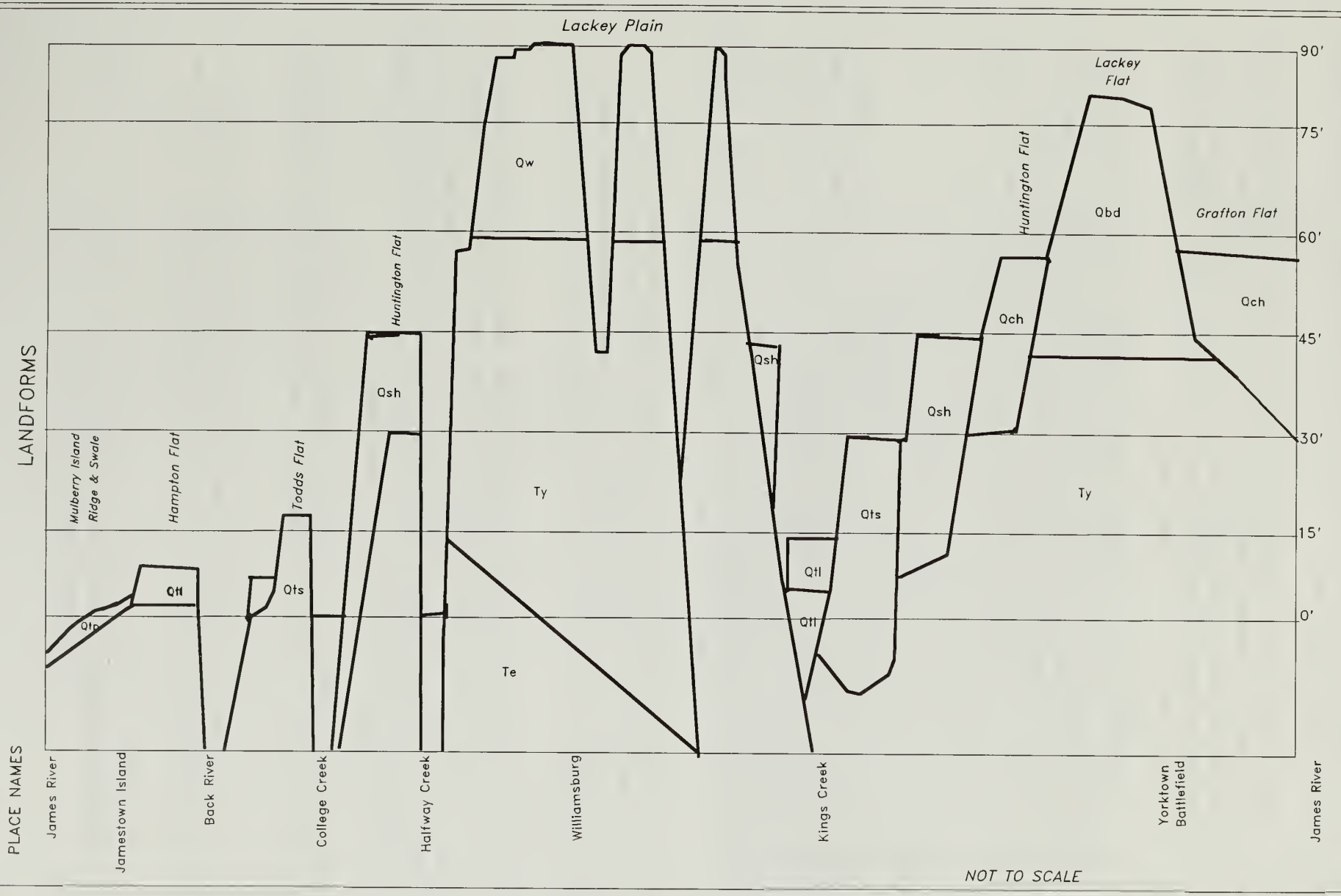
[1]This section prepared by Dr. Gerald Johnson



Colonial NHP and Environs

Figure 7 - Schematic Geological Cross Section of Colonial NHP from Jamestown to Yorktown, Virginia

USNPS, COLONIAL NHP – GIS•MDS

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DATE CREATED: 07/22/94

elevation to over 80 feet. This area is an intricately dissected upland (Lackey plain) with a dendritic drainage pattern and local relief of 70 feet. For much of its route the Parkway follows stream valleys eroded by tributaries of the College Creek.

The eastern section of Parkway (from Williamsburg to Yorktown) crosses a dissected upland nearly perpendicular to the north and northeast trending creeks that drain into the York River. Local relief ranges from 30 to 80 feet. Broad salt marshes occupy the valley floors. From King Creek to the vicinity of Yorktown, the Parkway is built upon a series of river-parallel terraces. The three terraces range in elevation from about 10 feet to 55 feet above MSL.

The Yorktown Battlefield is situated on the Lackey plain at an elevation of 80 feet and the Grafton flat at an elevation of 50 to 60 feet. Short, steep gradient streams draining to the York River have cut deep valleys into the northern part of the Battlefield. The southern part of the Battlefield drains into the James River through comparatively long streams, such as the Warwick River and its tributaries (Beaverdam Creek, Baptist and Great Runs). These valleys are shallow and without steep valley walls.

Stratigraphy[2]

The park crosses the York-James Peninsula, a terrain underlain by sediments ranging in age from Cretaceous to Holocene. The oldest exposed formation, the Yorktown, only crops out in deep valleys and river bluffs. Most of the surficial formations are composed of nonfossiliferous stream, bay and tidal river sediments. The York-James Peninsula near Jamestown is underlain by about 1000 feet of sediment deposited on the southern flank of the Salisbury Embayment during the Cretaceous period and Cenozoic Era. The thickness of sediment increases to near 1600 feet near Yorktown. The oldest deposits rest on rocks of Paleozoic to Triassic ages. The sequence of sediments is found in Table 4.

The Cretaceous formations in the Potomac Group is comprised of thick sequences of feldspathic sand and gravel and interbedded with thick clay. The Cretaceous sediments were deposited under fluvial-deltaic conditions. The Potomac is divisible into three (lower, middle and upper) aquifers separated by two major confining beds (see Figure 8). The upper Potomac is clay-rich and forms an upper confining bed.

The Potomac Group is overlain by a marine unit, the Brightseat, which is a micaceous quartzose fine sand and silt. The Aquia Formations rests unconformably on the older formation. It is a permeable shelly glauconitic quartz sand up to 75 feet thick. The Aquia is an aquifer. The Marlboro Clay, an impervious kaolintic clay-silt, constitutes a confining bed between the underlying Aquia and overlying shelley, micaceous, glauconitic, quartz sand of the Nanjemoy Formation. The Piney Point Formation is a very fossiliferous glauconitic sand and is a regional aquifer.

The Chesapeake Group is comprised of a sequence of fossiliferous clayey to silty sands, shelly sand, silty clay and diatomaceous earth (Figure 9). The Calvert and Choptank formations are principally clayey.

The clay-rich units in the lower Chesapeake Group and in the lower Eastover are confining beds. The upper Eastover and lower Yorktown is a major shallow aquifer within the park. The Eastover

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[2] This section prepared by Dr. Gerald Johnson

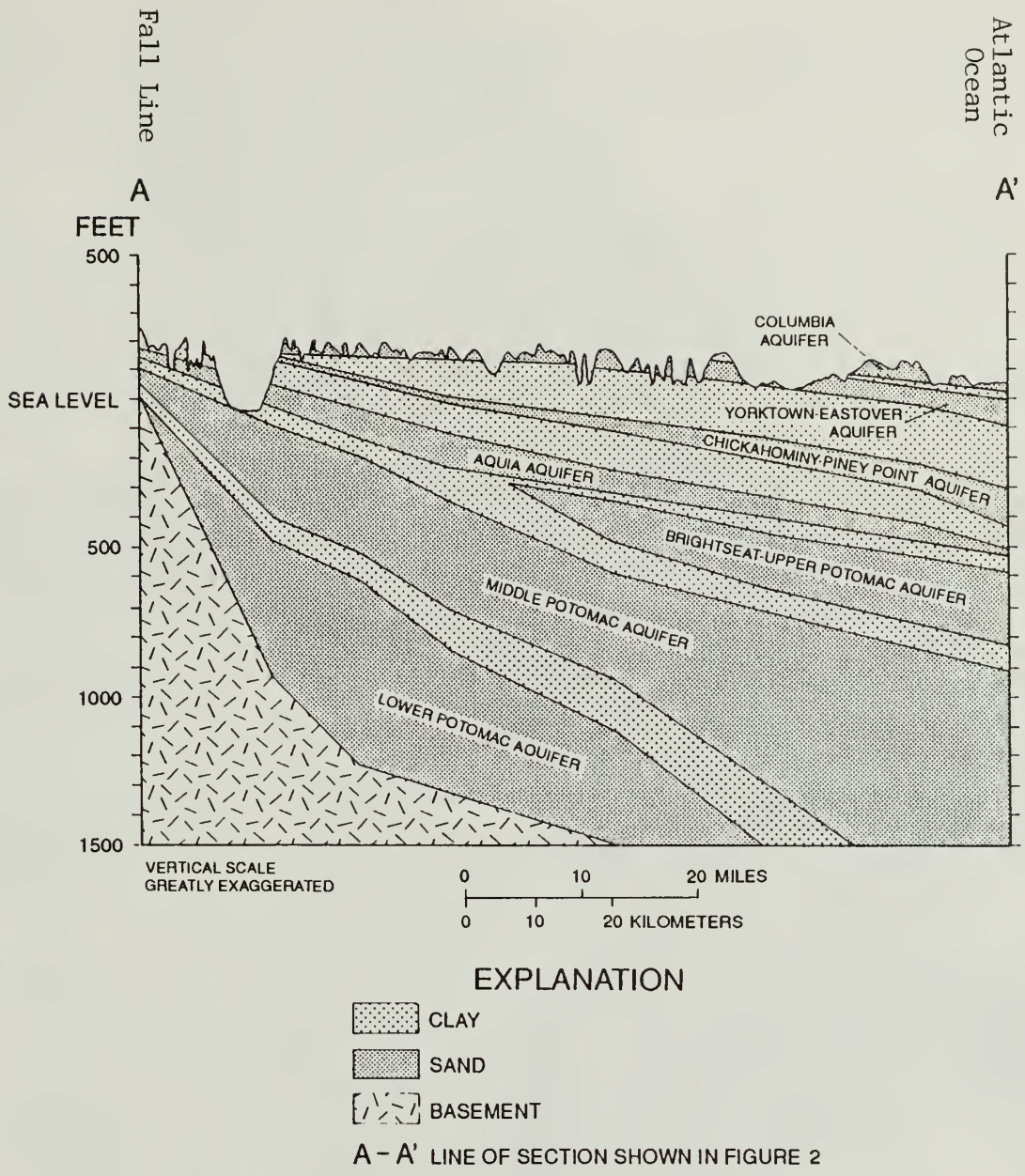

Figure 8 --Generalized geohydrologic section of eastward-thickening wedge of alternating sand and clay. (Modified from Harsh and Laczniak, 1990)

(M.J. Focazio, et al, 1993)

"Poquosan Member"
"Chesapeake Group"
"Shirley Formation"
"Sedgefield Member"
"Alluvium"
"Bacons Castle Formation"
"Chuckatuck Formation"
"Lynnhaven Member"
"Artificial Fill"
"Windsor Formation"
"Charles City Formation"
"Water"
Colonial NHP

Colonial NHP and Environs

Figure 9 GEOLOGY

Meters
0 2000 4000

USNPS, COLONIAL NHP - GIS•MDS
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DATE: 07/23/94 REV: #7
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This map adapted from R.B. Mixan, C.R. Berquist, W.L. Newell, and G.H. Johnson. 1989. Geologic Map of the Coastal Plain and Adjacent Parts of the Piedmont, VA USGS, MAP I-2033

and Yorktown formations underlie much of the park. These marine formations contain large quantities of shell and shell debris as well as quartz. The lower Eastover is a clayey silty fine sand and constitutes a confirming layer. They yield calcium-rich groundwater to streams and lakes and are leached to form the numerous sinkholes within the park. The Yorktown Formation is well exposed in the bluffs extending from Cornwallis Cave to the Moore House.

The Windsor, Charles City, Chuckatuck, and Shirley formations all exhibit common textural and mineralogic properties. Nearly everywhere in the park these formations consist of a basal gravelly bed and an intermediate sand that upward into a surficial mud. Individual formations are distinguished by their topographic position and by their degree of weathering. Quartz is the dominant mineral and although shells and peat have been reported from the Shirley Formation on the York-James Peninsula, none has been found on CNHP grounds. Whereas the clayey upper part of these formations impede infiltration, the lower permeable sediments are local aquifers and yield acidic groundwater.

Table 4. Stratigraphy

Series	Geologic Unit	Aquifer
Holocene	"Kennon Formation" (Alluvial and Marsh deposits)	Columbia
Upper Pleistocene	Tabb Formation Poquoson Member Lynnhaven Member Sedgefield Member	" " " "
Upper and Lower Pleistocene	Shirley Formation Chuckatuck Formation Charles City formation Windsor Formation	" " * Columbia
Pliocene	Moorings Unit Bacons Castle Formation Chowan River Formation Yorktown Formation	* * * Lower Yorktown-Eastover
Miocene	Eastover Formation St. Marys Formation Choptank Formation Calvert Formation	* *
Oligocene	Old Church Formation	*
Eocene	Chickahominy Formation Piney Point Formation Nanjemay Formation	Chickahominy- Piney Point
Paleocene	Marlboro Clay Aquifer Formation Brightseat Formation	 Aquia *
Cretaceous		Upper, Middle, Lower

*** not found in park**

The Tabb Formation is the principal surficial formation on Jamestown Island and along the Parkway between the Island and College Creek. The members of the Tabb are comprised of a lower pebbly sand with scattered cobbles, a middle medium to fine sand, and an upper silty and clayey fine sand. They range in thickness from less than a foot near bounding scarps to more than 20 feet in paleovalleys. The mineralogy of members is principally quartzose with minor amounts of heavy minerals. The surficial fine-grained unit of the Tabb formations impedes but does not preclude infiltration. The lower sandy units are local aquifers and yield mildly acidic groundwater.

Alluvial, marsh, swamp, beach, estuarine and mass wastage deposits are widespread in the park. Alluvial silt. sand, and gravel and reworked shell floor almost every upland stream floor. These deposits and channels are typical compressible, water-saturated, and organic-rich.

Alluvial sediments typically grade or intertongue with swamp deposits downstream. Swamp deposits consist commonly of dark brown to black peat and organic-rich silt, clay and fine sand. Roots, logs and detrital organic matter are also present. Thick swamps deposits are buried beneath younger sediments in almost every major valley in the park. Dark gray to bluish gray, organic-rich silt and clay accumulate in or lie buried beneath marshes at or near sea level throughout the park. Beach sand occurs along the shores of the York and James rivers. Beach deposits are composed principally of quartz, but along many reaches of the James and York, shells eroded from the bluffs and modern shell from the nearshore environment are interspersed with the quartz. The sand is derived from the erosion of the adjacent cliff and less commonly from offshore. Beaches are absent or dwindling where shoreline protection devices have been emplaced. Creep, sheetwash, slump and other mass wastage deposits cover most slopes within the park.

Most Holocene sediments are highly compressible, water saturated, organic-bearing and yield highly acid water to nearby streams.

Soils[3]

Jamestown Island soils are divisable into three major groups: the marshes, central uplands, and southern ridge and swale. The marshes along Powhatan Creek, Back River, Kingsmill Creek and Passmore Creek and its tributaries on or near Jamestown (and along Halfway, King and Felgate Creeks on the eastern section of the Parkway) are underlain by highly compressible, water-saturated Bohichet mud, Levy silty clay. These soils develop under brackish, diurnally inundated tidal waters and, consequently, are very poorly drained, organic-rich, and strongly acid to mildly alkaline. The soils on the ridges south of Passamore Creek include the somewhat poorly drained low-lying Dragston and Newflat soils, the moderately well drained Dogue and Tetotum series, and the well drained topographically higher State soil. Sandy beaches with no significant soil development occurs along Goose Hill on Jamestown Island and along the Colonial Parkway east of King Creek. Tetotum and Tomotley series are the dominant soils of the higher parts of Jamestown Island. The poorly drained Tetotum and Tomotley soils are moderately to slowly permeable and have seasonally high water table at depths of 1 to 1 1/2 feet.

The soils along the Colonial Parkway from Jamestown Island to College Creek occur on low terraces (Dogue and Pamunkey) and on road fill (Udorthents); locally transverse streams (Powhatan, Mill and College Creeks) flow through marshes underlain by the Levy series. The Dogue and Pamunkey

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[3] This section prepared by Dr. Gerald Johnson

Series are moderately well to well drained, loamy to clayey soils with seasonally high water tables. The land is flat to gently sloping (0 to 6 percent) and steep slopes and bluffs are only found along the eroding shoreline. Extensive tracts of disturbed soils, mostly mapped as Udorthents, occur along the parkway and roadways throughout the park. These soils have truncated profiles, or are comprised of road fill, or solid waste in pits. These soils have highly variable pH, texture and depth to groundwater. The solid waste in pits may adversely effect water quality.

The Parkway between College Creek and Halfway is underlain mainly by the deep, moderately well drained Peawick silt loam. This soil has low permeability and seasonally high water table, and extremely to strongly acid. Between Halfway Creek and Yorktown Battlefield, the soil (Craven-Uchee, Emporia, Johnston, Slagle, Suffolk and Udorthents series) are highly variable because of the terrain and differing parent materials. The Emporia soils are most typical of this area and are moderately permeability, well drained, strongly to very strongly acid, and with a perched water table at 3 to 4 1/2 feet. The other soils are similar to the Emporia but differ slightly in permeability, drainage, slope and position of the water table. Udorthents are common on the Parkway along the York River. Scattered areas of Dogue loam, Kempsville and Pamunkey soils are also found along this section of the Parkway.

The most common soil of the Yorktown Battlefield is the flat to gently sloping soils of the Slagle series. The Slagle is a moderately well drained, moderate permeability, perched seasonally high water table at 1.5 to 3 feet, and Emporia, Kempsville, Cranen-Uchee very strongly to extremely acid.

The Slagle series is the dominant soil on the flat to gently sloping (2 to 6 percent) northern half of Green Springs unit above the Kingsmill scarp. Newflat silt loam is the principal soil over the southwest part of Green Springs, and Chickahomny silt loam mostly covers the southeast part of the tract. The Slagle in a moderately well drained, strongly to extremely acid, sandy clay loam with low permeability and seasonally high water table. The Chickahomny is a nearly flat (0 to 2 percent slopes), poorly drained silty clay to clay loam with very slow permeability, high shrink-swell potential and seasonally high water table.

The park contracted with the U.S. Department of Agriculture's Soil Conservation Service, Richmond, Virginia to produce a digital soil survey and drainage record for inclusion in the COLO GIS database. This survey covered park lands and 1000 foot buffer zone along the boundary. Figure 10 represents the general soil series, not the detailed survey in the GIS.

Colonial NHP and Environs

Figure 10 GENERAL SOIL MAP

Water Quality

Preliminary findings indicate generally good water quality in most surface waters within the park (Swihart and Spells, 1987; 1992), however, more information is needed on heavy metals and certain pollutants before the water quality can be fully understood. Most of the water bodies and wetlands in the park have major portions of their drainage basin upstream stretches outside of park boundaries. As a result, activities outside of the park can have a detrimental affect on water quality within the park.

Both point and non-point sources of pollution may affect water quality in the vicinity of the park. Amoco, Virginia Power, and the Hampton Roads Sanitation District have Virginia Pollution Discharge Elimination System permits on the York River. Low levels of dissolved oxygen, pH imbalance, and bacterial contamination in many upstream tributaries are all potential pollution problems for the York River (Commonwealth of Va, 1990a).

The Virginia Department of Environmental Quality (DEQ) has several monitoring stations in the lower York and James river drainages in the vicinity of the park (Table 5). Water quality at these sites is monitored for four basic parameters including water temperature, dissolved oxygen, pH, and fecal coliform bacteria.

Table 5. Virginia DEQ Water Quality Monitoring Sites in the Vicinity of Colonial NHP

Site Number	Location	Parameters	Period of Record
James River Drainage (up river from mouth)			
W86 2-JMS032.59	32 miles from mouth, Red buoy N36	Temp., DO, pH, coli. bacteria, metals, pesticides	7/1/87 - 6/30/89
W85 2-CHK002.17	2 miles to Chickahominy River, Rt.5. James City - Charles City Co. line	same	7/1/87 - 6/30/89
W124 2-JMS042.92	Swann's Pt. 42 miles from mouth	same	7/1/87 - 6/30/89
York River Drainage (up river from mouth)			
W15 8-YRK004.56	Buoy 2, 4 miles from mouth	same	7/1/87 - 6/30/89
W16 YRK011.14	Buoy N34, 11 miles from mouth	same	7/1/87 - 6/30/89
W17 8-YRK022.70	Buoy N44, 22 miles from mouth	same	7/1/87 - 6/30/89

The York River is classified as being effluent limited, meaning that the legally mandated minimum waste treatment requirement applied to the effluent of a waste treatment plant are sufficient to meet water quality standards. On the York River, several sites near the park are monitored to evaluate the parameters described above. The results are reported to represent the percent of time the water quality assessment failed to meet minimum water quality standards. No violations were reported for temperature, pH, or fecal coliform. All stations failed to meet DO criteria between five and seven percent of the time (Commonwealth of Virginia, 1990a). Additionally, shellfish areas have been condemned in this segment of the river from Taskinas Creek, above the park, to Sarah's Creek, across from Yorktown. Most of these closures are related to buffer zones surrounding point and non-point source pollution sites. (Commonwealth of Virginia, 1990a).

In the 1970's, the discovery of the insecticide, kepone (chlordecone) in the James River caused the River and its tributaries to be condemned for fishing shellfish and finfish from Richmond to Newport News. An estimated 199,000 lb (90,720 kg) of this chlorinated hydrocarbon had been released through atmospheric emissions, waste water discharge, and bulk disposal resulting in the closure of the James River to fishing and shell fishing from the 1970s through the mid-1980s. By 1988, all fishing bans had been lifted. However, shellfish closures continue in some areas of the river, though these are due largely to the requirement for buffer zones around areas of heavy industrial or commercial utilization and in high boat traffic areas.

Today on the James River there are several monitoring stations upstream and downstream of the park (Table 5). The stations closest to the park include: 1) the mouth of the Chickahominy River (upstream), 2) Swann's Point (across from Jamestown Island), and 3) Hog Island (downstream). Industrial discharge from the Surry Nuclear Power Plant is the major point source pollution on the James River in the vicinity of park waters. Other potential local sources of water quality degradation in the James River drainage include leachate from the James City County landfill, impacts of nonpoint sources such as agricultural areas and storm water runoff not covered by the NPDES program, septic field leachate, and pollution associated with discharges from boats and marinas. However, there were no reported compliance violations at any of the James River monitoring sites within the vicinity of the park (Commonwealth of Virginia, 1990a).

With the expanding urban population, water quality problems may continue to grow in the York River and James River watersheds within the vicinity of the park. Recreational and commercial boating in the area bring with them resultant pollution from marinas and improper waste discharge. Non-point source pollution including storm water runoff not covered by the NPDES program, leachate from septic systems and abandoned landfills, and erosion and sedimentation will present serious challenges to maintaining the generally good quality of the park's waters into the future.

Erosion and Sedimentation

Erosion and sedimentation are management problems throughout the park. Both affects the integrity and stability of park shorelines, water quality, and natural and cultural resources. Its causes are both natural and anthropogenic.

Erosion is a significant process along the river shorelines of the park. Much of the erosion results from normal and storm induced wave activity, yet impacts resulting from recreational use are also a concern (Rafkind et al., 1990). Severe erosion has been noted at specific points along the York and James River, especially Jamestown Island, the cliffs below the Yorktown Visitor Center (Hubbard, 1989), and the shoreline fronting the Glass House at Jamestown. Shoreline recession threatens the cultural resources of Jamestown Island, Glasshouse Point, and Yorktown, and is responsible for the

aereal reduction in intertidal wetland communities along Jamestown Island. It is unknown if this is due to erosion from wave action or sea level rise or both.

Access to and from the shoreline by recreational fishing produces localized impacts on the natural resources due to trampling. Trampling and loss of vegetative cover acts to accelerate erosion problems. In general, however, these activities are not widespread enough to produce an overall threat to the park's resources.

Non-point source pollution resulting from erosion and sedimentation poses a threat to park water quality and natural resources. Park management has taken several actions within and outside the park to reduce erosion and sedimentation impacts to wetlands, streams, tidal rivers and the associated aquatic resources. Changes to park mowing practices have been implemented to reduce erosion and sedimentation problems inside the park. Allowing the vegetation to thrive along fields and shorelines helps to reduce impacts from rain, wind, and reduces trampling impacts from recreational use. Decreased mowing in the fields in Yorktown and the open roadside areas along the parkway encourages the growth of native grasses and herbaceous species, and reduces the dominance of exotic species. Additionally, natural growth and germination eliminates most needs for revegetation actions involving the use of chemical fertilizers and non-native grasses.

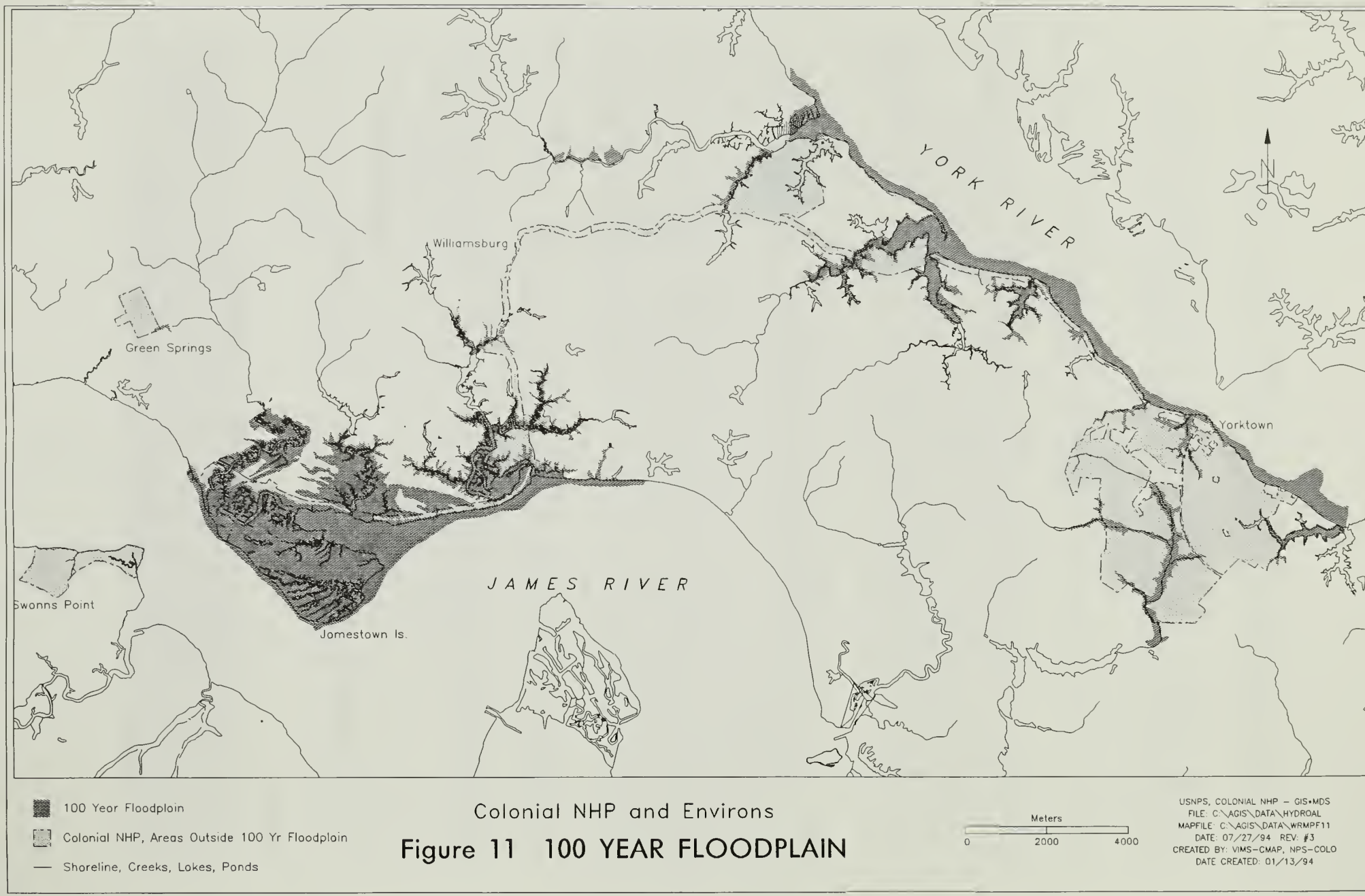
The park conducts a stringent environmental assessment and enforcement program dealing with numerous utility rights-of-ways (ROWs) that criss-cross through the park. This ensures that the actions of permittees do not increase erosion and sedimentation problems during construction and maintenance of these areas.

A management plan for the Yorktown bluffs, which contains the remains of British (1781) and Civil War earthworks, have been implemented in an attempt to curb the severe erosion problem caused by recreational use (Rafkind et al., 1990). Personnel from all park divisions assisted in the design and implementation of management actions to control erosion on numerous informal trails along the Yorktown bluffs and trails leading to the river below. Serious erosion problems have developed from the overuse of these social trails, which have accelerated the natural slumping action of the bluffs. The plan emphasizes the use of natural vegetation barriers, including planting of native bushes, no-cut zones for adjoining open fields, and repairing and expanding present fencing and signing.

While management efforts within the park can reduce erosion from park lands, erosion from lands adjacent to the park may still impact the park's aquatic resources. Development on adjacent lands has decreased the water holding capabilities of the watershed and thus increased the water flow into the park. This has caused the scouring of park creeks and streambanks, resulting in unnatural sedimentation in some park waterways. It is essential that the park continue to work with local and state regulatory and planning authorities to insure the enforcement of erosion and sedimentation regulations for adjacent land use changes, and improve storm water management.

Floodplains

The Flood Plain Insurance Rate Maps (Federal Emergency Management Agency, 1988, 1991) produced by the Federal Emergency Management Agency (FEMA) provide the only current source of floodplain delineation information for the park and its environs. According to these 1:12,000 scale maps, approximately 33 percent, or 3,061 acres (1,239 hectares) of the park is located within the 100-year floodplain (Figure 11). The majority of these areas lie within James City County.



100 Yeor Floodploin

Colonial NHP, Areas Outside 100 Yr Floodploin

— Shoreline, Creeks, Lokes, Ponds

Colonial NHP and Environs

Figure 11 100 YEAR FLOODPLAIN

Meters

0 2000 4000

USNPS, COLONIAL NHP – GIS•MDS
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DATE: 07/27/94 REV: #3
CREATED BY: VIMS-CMAP, NPS-COLO
DATE CREATED: 01/13/94

This value was calculated from data derived off the current Flood Insurance Rate Maps (FIRM). The floodplain GIS coverage developed for this plan was used to compute the acreage (Figure 11). The reported value is based on the current GIS coverage for the park boundary and the delineated 100-year floodplain digitized at 1:24,000.

The FIRM data represents the only available source of information for inclusion in a floodplain management plan. Unfortunately, the value of this data has come under great scrutiny nationwide. While the program to develop these maps was administered by FEMA, the consulting firm Dewberry and Davis managed the quality control and standardization of the data to produce the final products. The actual data collection was the responsibility of the local counties and jurisdictions, where mapping and methodologies were not standardized or well documented. A new effort is underway to transfer the current FIRM maps to digital format. The Virginia Department of Environmental Quality has been contracted by FEMA to manage the quality control according to FEMA guidelines. At this time it is not known if the digital data will improve on some of the original problems with the map products.

Groundwater Resources

Groundwater recharges through precipitation and seepage through overlying confining units. Natural groundwater quality is a function of the chemical weathering process of sediments as water percolates through both aquifers and the confining units of an aquifer system. As might be expected then, natural groundwater levels tend to fluctuate seasonally as a result of precipitation, but slow rates of flow through thicker confining units (requiring centuries to millenia) shield the deeper aquifers from fluctuation with precipitation. Fluctuation in the deeper aquifers results from pumping or tidal loading (Personal Communications, Brockman, A.R., U.S. Geological Service, 1994). Along the coastal plain of Virginia, the dissolution of calcite through the decomposition of shell material in the confining units results in high concentrations of calcium and bicarbonate in the groundwater. The reduction of ferric iron in anaerobic water to dissolved ferrous iron produces high iron concentrations (Richardson and Brockman, 1992). This produces a groundwater chemically characterized as hard water with high iron concentrations. Neither is a threat to human health, but in some areas, particularly in eastern York County, the water is undesirable for drinking. More water quality sampling is needed to determine if iron and hardness are more excessive in eastern York County or throughout the areas of York and James City County (Personal Communications, Brockman, A.R.).

While no one study has specifically addressed the groundwater resources within the park, several reports by the U.S. Geological Survey (USGS) have provided information on both the regional hydrogeology, and to a lesser degree, the water quality of the shallow water aquifer systems within James City County and York County (Harsh, 1980; Brockman and Richardson, 1992; Richardson and Brockman, 1992).

In York County there are three shallow (< 200 feet in depth) aquifers; the Columbia (upper), the Cornwallis Cave (middle), and the Yorktown-Eastover (lower) (Figure 8). The Columbia and Yorktown-Eastover aquifer are both used for domestic water supply to areas not serviced by municipal water suppliers. The Yorktown-Eastover aquifer ranges in thickness from 40 feet to 100 feet, and with yields less than 10 gallons per minute (Brockman and Richardson, 1992). The Eocene-Paleocene and Cretaceous aquifers underlying the shallow aquifer system in both York County and James City County halves of the park contain water with have chloride concentrations exceeding the EPA's Secondary Maximum Contaminant Level of 250 mg/l (Larson, 1981), and are therefore not suitable for consumption.

Richardson and Brockman (1992) report that water quality degradation from man-made sources is localized and not (regionally) apparent. However, the introduction of pollutants through septic-system effluent, fertilizers, pesticide use, and road salting are all potential groundwater contaminants. To date, water quality monitoring at well sites in the York County area indicate that nitrogen and phosphorous concentrations are near or below detection levels, and that human activities are not posing a significant threat to groundwater quality at this time. However, saltwater intrusion into groundwater supplies is a possibility if industrial or commercial water withdrawals causes a profound reduction in water levels.

Recent groundwater management and monitoring efforts within York County are limited. The county-wide dependence on the Newport News Waterworks has reduced the interest in active groundwater resource management by the local governments. Therefore, little information regarding trends in groundwater withdrawals, groundwater quality, or future demands in York County is available.

The James City County Service Authority (JCSA) maintains a system of water supply and groundwater monitoring wells throughout James City County. Chemical analyses are done every three years by analyzing a sample from a source at the confluence of conduits from all of the system wells. Therefore limited groundwater quality data are available from individual wells. Water quality data from new wells that have recently come on line are available, but the number of parameters tested is limited.

Harsh (1980) provides the most recent comprehensive evaluation of groundwater resources for James City County, which includes Jamestown Island. Four principal aquifers serve this area. The uppermost aquifer, known as the Quaternary Aquifer is available for small water supplies. This aquifer, while small, is also important because it serves as the source for recharge to the underlying aquifer systems. The aquifer is located about 40 feet below the ground surface and ranges in thickness from 10 feet to 70 feet. Therefore this aquifer is subject to pollution from septic systems as well as fertilizer and pesticide runoff from residential and agricultural areas.

The park, in cooperation, with researchers from the Virginia Institute of Marine Science (MacIntyre and Libelo, 1993) have undertaken a study to investigate the effects of adjacent urban and agricultural development on the shallow groundwater and selected surface water resources of the park. Four quarters of sampling for this one year study have been completed. Initial testing indicates potential local sources of groundwater contamination from nitrate and ammonia at several sites near Jamestown Island, Williamsburg, and Yorktown. Salinity and phosphate concentrations were low or below detectable levels (Libelo and MacIntyre, 1993).

Below the Quaternary Aquifer, the Yorktown and the Eocene-Paleocene aquifers comprise the middle hydrologic units. The Yorktown Aquifer supplies water for domestic uses in Williamsburg and Norge and has an estimated water store of 45 to 100 billion gallons. The Eocene-Paleocene Aquifer has slightly less groundwater stored (35 to 90 billion gallons), and supplies water to domestic wells from Jamestown to the Chickahominy River.

The Cretaceous Aquifer is the lowest unit in the aquifer system, but also the most productive and extensive. Estimated maximum amounts of groundwater in storage range between 545 and 1,050 billion gallons. In 1978, total pumpage was estimated to be 7 million gallons/day (Harsh, 1980). Primary withdrawal from this aquifer is from municipalities and industrial users. Overall water quality in this aquifer is considered good, although sodium and bicarbonate concentrations are slightly elevated (Harsh, 1980).

A search for additional sources of information pertaining to the groundwater resources in and around the park was undertaken in 1991. While some additional site specific information was found, it was not in a form that could provide a more up-to-date assessment of the status of water resources in the vicinity of the park. While the Department of Environmental Quality (DEQ) office in Virginia Beach serves as a clearing house for much of the data collection conducted at the state and local level, no automated database exists to allow for rapid retrieval or efficient updating of the records.

Perhaps the biggest obstacle in the consolidation of the data researched is the fact that there is no standard reference guidelines for water resources data. For example, Virginia Department of Environmental Quality, the U. S. Geological Survey, James City County Service Authority, and the Virginia Department of Health all maintain potentially relevant databases of varying sizes. However, each agency uses a different indexing system, making it extremely difficult to locate site locations from system to system.

In summary, while regional hydrogeologic information for the York-James Peninsula is available, local information relating to the potential impacts of water withdrawal upon park resources is not readily available.

Water Uses

There are no large consumptive uses of water within the park. Water for park operations, visitor use, and maintenance activities are generally supplied by the surrounding municipalities. The park receives most of its public drinking water from the Newport News Waterworks, City of Williamsburg, and James City County Service Authority. The park operates public water supplies, from well water, at the Jamestown Island Visitor Center and the Glasshouse.

The Yorktown National Cemetery and residence is served by a septic tank. All other sites receive sewage treatment from the Hampton Roads Sanitation District and James City County Public Service Authority.

Maintenance of natural flow patterns and hydroperiod are important for sustaining the water-related resource features in the park as well as enhancing the recreational and aesthetic qualities of the park. The streams and ponds within the park, as well as the waters of the York and James rivers are all important in sustaining these resource values. In addition, freshwater in shallow aquifers is locally important for the maintenance of nontidal wetlands and ponds within the park.

The quantity of water necessary to support these features is not currently understood. Management of water resources to support these features will require more information on the hydrology of the park area and coordination with local and state management programs in the surrounding area.

Status of Water Rights

Legal aspects of water rights in Virginia are based on British common law precedents as modified by State law and interpreted by the courts since the time of settlement. In Virginia, this manifests itself through the doctrine of riparian water rights. The riparian doctrine defines water rights primarily by ownership of contiguous land adjacent to the water resource, and secondarily by the type of utilization. Since the Federal government owns the land within the park, the National Park Service

has rights to surface and subsurface water within the boundaries of the park. Riparian water rights are limited to reasonable use and must be utilized on lands that are adjacent to the water source. Recent modifications to Virginia water law include permit requirements for all surface water use in designated surface water management areas (Virginia State Water Control Law (as amended) and for groundwater use exceeding 300,000 gallons per month per well in designated groundwater management areas (Virginia Groundwater Management Act of 1992). At present, there are no designated surface water management areas in the state. However, the counties containing Colonial National Historical Park (including York County, James City County, and Surry County) have been designated groundwater management areas. Permitting regulations provide for public notice, opportunities to comment and determination of required mitigation in response to proposed water development.

At this time there are no outstanding water rights issues requiring park management consideration. However, cooperation with the Virginia Department of Environmental Quality is encouraged to assure that future water development issues within the region do not adversely affect park water related resources.

Underground Storage Tanks

Colonial National Historical Park maintains a number of underground storage tanks (USTs) in order to support park operations and maintenance activities. A 1991 survey revealed 30 known USTs within the park, including 26 used to store fuel oil and 4 used to store gasoline. In 1991, the park tested all of these tanks in accordance with state UST regulations. While all tanks passed the testing, the park replaced USTs at the visitor centers (2), maintenance facilities (2)(fueling areas), ranger office (1), and selected park residences (4) (Personal communications, Roy Bigelow, Colonial NHP, 1993). A leak was discovered during the UST replacement operation at the Yorktown Visitor Center (1992). A site characterization study was conducted at this site and soil and groundwater samples were tested over a one year period under the guidance of the Virginia State Water Control Board. No contamination of soils or groundwater was found (Personal Communications, Roy Bigelow, Colonial NHP).

The park also removed two inactive 50 gallon generator fuel oil tanks at College and Mill Creeks formerly used to power navigational lights. Also, five fuel oil tanks were removed from residences and replaced with heat pumps or natural gas systems. Over the next six years 17 additional USTs will be removed from the park and replaced with natural gas systems.

External Spills and Leaks

Over the past several years, there have been periodic fuel oil and sewerage spills and leaks from outside of the park which have contaminated park waters. All spills and leaks have been investigated by Virginia Department of Environmental Quality (or its predecessor - the Virginia Water Control Board).

A series of fuel spills and leaks, and one sewerage spill entered Papermill Creek and an unnamed creek from buildings owned by Colonial Williamsburg adjacent to the park. Shallow groundwater monitoring wells, as well as surface observation points have been used to locate and monitor the sources of the leaking USTs at bus maintenance facility. No long-term impacts have been observed. Colonial Williamsburg has taken the appropriate corrective actions including spill mitigation, tank

replacement, and follow-up monitoring. In addition, Colonial Williamsburg is currently working to replace the use of fuel oil with natural gas where feasible.

A major spill involving approximately 4500 gallons of heating fuel entered Papermill Creek from the adjacent National Center for State Courts, in 1991. No long-term impacts to park resources from this spill have been observed. However, the National Center for State Courts has replaced fuel oil with natural gas service in order to eliminate any future problems.

An additional petroleum-related leak, in 1991, from a York County sewerage pumping station entered Great Run Creek, in the Yorktown unit of the park. The problem was corrected promptly, and no long-term damage to park resources was observed. New procedures have been implemented by York County in order to reduce the probability of repeat episodes.

Two known sewerage line breaks, in 1991 and 1993, from Hampton Roads Sanitation Authority are reported to have entered park and public waters along the James River. While the breaks were repaired promptly, the Virginia Department of Health temporarily suspended commercial shellfishing in the vicinity of the sewerage line breaks.

External Hazardous Waste Disposal Sites

The park is adjacent to several hazardous waste materials disposal sites belonging to the Commonwealth of Virginia and the U.S. Navy. Extensive site investigations have been conducted on all these properties under the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Superfund Amendments Reauthorization Act (SARA) of 1986. The Department of Defense, and the U.S. Navy, have developed programs similar to the U.S. Environmental Protection Agency's managed superfund programs. The park sits on the U.S. Navy Technical Review Committees for these sites, while communicating directly with the Commonwealth of Virginia's manager of investigations and clean-up.

Commonwealth of Virginia Emergency Fuel Storage Facility (Cheatham Annex)

The Commonwealth of Virginia currently owns a 435-acre fuel storage facility located in western York County adjacent to the Colonial Parkway. The site, known as Commonwealth of Virginia Emergency Fuel Storage Facility (CVEFSF), was formerly owned and operated by the U.S. Navy. This site lies within the Kings Creek sub-basin, which drains through the park into the York River. This facility contains 23 two-million gallon underground storage tanks which have stored various petroleum products including No. 2 fuel oil, kerosene, gasoline, oil, and various special Navy and aviation fuels. A site investigation has been conducted over the past several years and a remediation study proposal prepared (Commonwealth of Virginia, 1990b). While the site is neither on the Superfund list nor the National Priorities List (NPL), the Commonwealth of Virginia is negotiating with EPA and the U.S. Army Corps of Engineers regarding final site remediation. Remediation activities to date have included removal of all known PCB materials, equipment, and numerous small PCB stains from the soil and concrete pads. As well contracts have been initiated to remove petroleum sludge from pits and contaminated water and soil from the site. Cleaning of contaminants from the storage tanks, has not yet begun.

Off-site wells located to the west of the facility are currently being monitored by the York County Health Department. To date, neither on-site nor off-site monitoring wells have indicated significant

groundwater contamination (Commonwealth of Virginia, 1990b). Currently, outflow from the site is being monitored on both a monthly and quarterly basis by the Virginia Department of Environmental Quality for a number of petroleum-associated inorganic and organic constituents.

Additional on-site monitoring has been undertaken at the CVEFSF site of surface waters and sediments of the on-site pond. Additional downstream monitoring of water, sediments, and shellfish are currently planned.

U.S. Navy Yorktown Fuel Depot

The Yorktown Naval Fuel Depot is located adjacent to Wormley Pond in the Yorktown Unit of the park. Soils, surface water, and groundwater assessments of the sludge farm area detected slightly elevated petroleum hydrocarbon concentrations. The terrain of the area grades away from the park and no migration into the adjacent Wormley Pond or Creek has been detected (U.S. Navy, 1992). Removal of several feet of contaminated soils at the sludge farm area is going through final approval process.

Interim actions for a previously detected oil plume from an underground storage tank has included the pumping from a groundwater testing well of any petroleum hydrocarbon concentration free product. Over the past year (1993-94) no additional free petroleum product has been recovered. Additional groundwater testing is planned to ascertain if the plume has spread or confirm that recovery has been successful. In another area of the depot petroleum hydrocarbon concentration free product is also being recovered from an underground plume. The Navy is currently designing remediation solutions for this site. No off-site migration has been detected.

U.S. Navy Yorktown Naval Weapons Station (NWS)

The Yorktown Naval Weapons Station is a 10,624 acre (4,300 hectare) site bounded by I-64 and the Colonial Parkway. Investigations at the NWS have previously identified 16 sites which have been utilized for hazardous waste disposal as far back as 1925 (U.S. Navy, 1993a). All sixteen sites are located upstream from the Colonial Parkway or adjacent to the Yorktown unit of the park.
The entire station has been added to the National Priorities List under CERCLA. An additional 19 sites have been targeted for preliminary assessment.

Site 12, approximately 4 acres (1.6 hectares), bounds Ballard Creek which is within the Yorktown unit of the park. Initial investigations at this site indicate that further assessment is necessary (U.S. Navy, 1993a). This assessment will be conducted following the standard remedial investigation and feasibility site program of the U.S. Navy.

Biological sampling of sites upstream from the Colonial Parkway has indicated that bioaccumulation has not occurred in the fish and shellfish populations of Lee Pond, Roosevelt Pond, Indian Field Creek, and Felgates Creek at levels high enough to pose a significant human health risk to the individuals who consumer or harvest finfish and shellfish from these waters (U.S. Navy, 1993a).

A draft Master Project Plan along with selected site plans have been developed for review, approval, and implementation as the next phase of the remedial investigation/feasibility study (U.S. Navy, 1993b).

CHAPTER 4. AQUATIC BIOLOGICAL RESOURCES AND HABITATS

Introduction

The aquatic biological resources of Colonial NHP include a wide variety of birds, fish, mammals, aquatic invertebrates, plants, and wetlands typical of the mid-Atlantic Coastal Plain. None of these resources are limited to the park lands, but park lands provide important habitat areas within the larger geographic area. The park contains significant aquatic habitats within the tidal mesohaline systems found along the shores of the York and James rivers and in most of the tidal creeks to those rivers. In addition, freshwater streams and ponds in the Yorktown unit and along the Colonial Parkway support a number of freshwater aquatic communities.

While none of these aquatic communities are unique within the larger geographic area, several areas have been identified as critical habitats by the Virginia Department of Conservation and Recreation, Division of Natural Heritage. These areas contain rare, threatened, and endangered (RTE) species. Also, the U.S. Fish and Wildlife Service (USFWS) has identified areas within the park that are utilized as nurseries for important commercial and recreational sport fishery species.

Protection of these aquatic communities is also important because the park provides unique opportunities for public observation, education, and recreational fishing. The roadways and access areas throughout the park afford opportunities for close examination of wetlands and waterfowl, as well as opportunities for swimming, fishing, and shellfishing. Many locations along the 23 mile Colonial parkway, Jamestown Island and Yorktown tour roads, and Yorktown waterfront are heavily utilized by the public for observation, relaxation, education, and fishing.

Four types of factors affect the aquatic biological resources of the park. These include the natural processes of climate change, which could affect the hydrology by both altering the amount of water moving through the park uplands and influencing the level of tidal waters along the shorelines. Climate change, being a "global-scale" issue, is obviously beyond the control of park managers. However, local processes, such as water quality management, erosion and sedimentation control, and public use may also affect the aquatic resources. Clearly defined management objectives, adequate planning, and good local coordination are essential in identifying and resolving the water resources issues influenced by these local processes.

Flora

National Park Service records report that 593 species of vascular plants from 98 families and 352 genera have been identified within the boundaries of the park (National Park Service, 1986b). Predominant vegetation types within the park include approximately 5,540 acres (2,242 hectares) of forest (including about 734 acres of forested wetlands), approximately 1,744 acres (706 hectares) of tidal and non-tidal emergent (herbaceous) wetlands, and approximately 1,119 acres (453 hectares) of open fields. An important function of the park flora is to screen the park from outside urban intrusions and to enhance its aesthetic environment.

Three types of forests grow on park lands. These include the pine, mixed pine and hardwood, and hardwood forest types. Loblolly (*Pinus taeda*) and Virginia pine (*Pinus virginiana*) are the dominant species. A number of hardwood species exist in both the wet and dry areas of the park. The dry species include tulip poplar (*Liriodendron tulipifera*), white oak (*Quercus alba*), willow oak (*Quercus phellos*), black cherry (*Prunus serotina*), red oak (*Quercus rubra*) and hickory (*Carya tomentosa*).

Hardwood species found in the wet or poorly drained soils include sweet gum (*Liquidambar styraciflua*), white ash (*Fraxinus americana*), red maple (*Acer rubrum*), black walnut (*Juglans nigra*), black gum (*Nyssa sylvatica*), and sycamore (*Platanus occidentalis*).

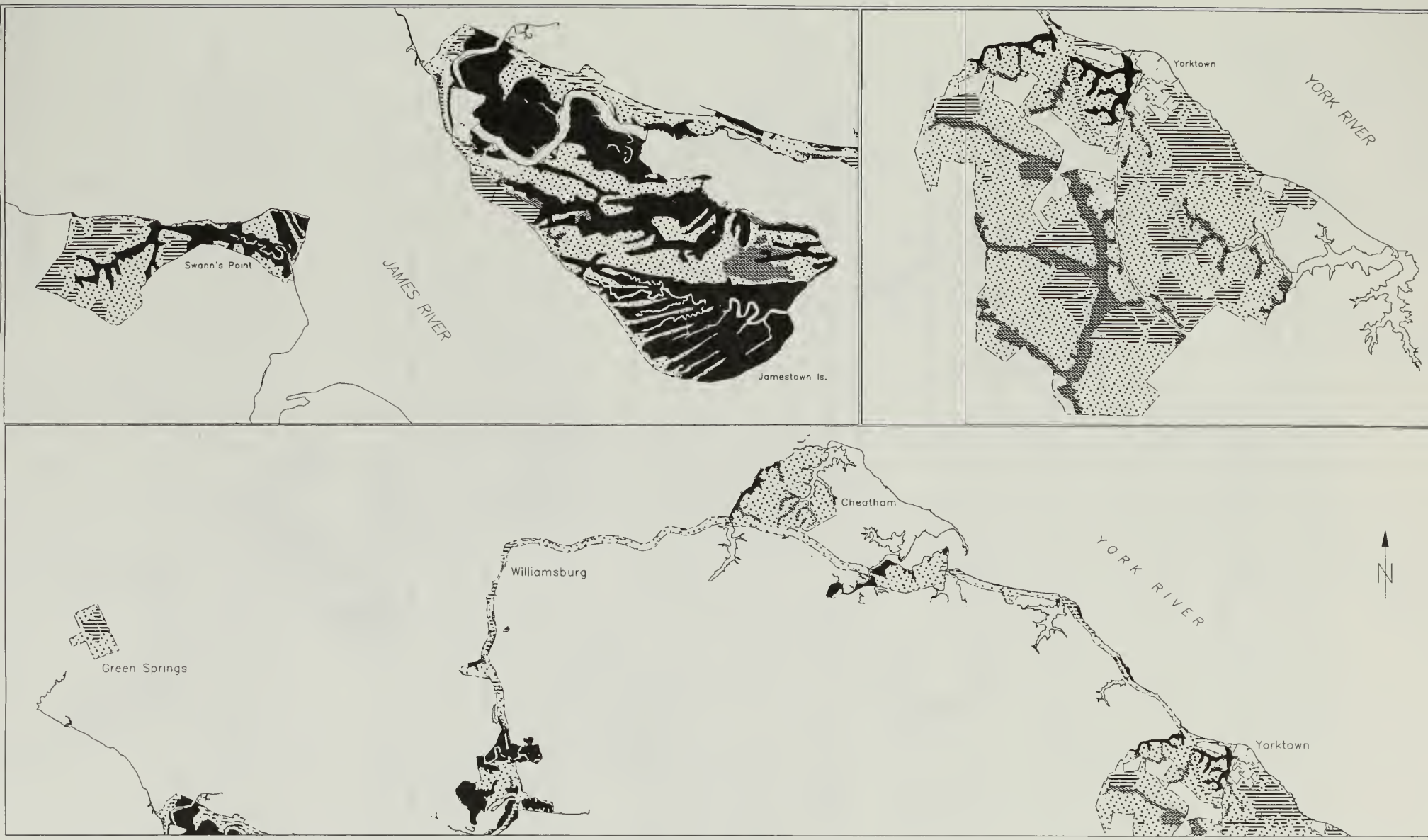
Growing along with the dominant overstory species are the plants of the understory which contribute to the diversity of park flora. These species include bedstraw (*Galium aparine*), hairy hawkweed (*Hieracium florentinum*), hay-scented fern (*Dennstaedtia punctilobula*), lady fern (*Athyrium asplenioides*), adder's tongue (*Botrychium ophioglossum*), poison ivy (*Toxicodendron radicans*), and holly (*Ilex opaca*). In addition to providing habitat for park animals, local flora also contributes to the beauty of the area which visitors to the park enjoy. Some of these flowering species are dogwood (*Cornus florida*), redbud (*Cercis canadensis*), paper mulberry (*Broussonetia papyrifera*), scotch-broom (*Cytisus scoparious*) and the Yorktown onion (*Allium ampeloprasum*), a species unique to Tidewater Virginia. Non-native species which have invaded much of the park include bamboo (*Arundinaria gigantea*), Johnson grass (*Sorghum halepense*), and kudzu (*Pueraria lobata*).

Each area of the park supports a different type of vegetation (Figure 12). On Jamestown Island are pine-oak forests in which loblolly pine is the dominant species. Extensive emergent and forested wetlands are found on the Island. At Yorktown extensive pine-oak forests are common, along with extensive fields and lawn areas. Loblolly pine and various oaks are the predominate species. There are extensive areas of emergent and forested wetlands on the York River and at Wormley Pond.

Pine-hardwood forests, fields, and emergent and forested wetlands span the length of the Colonial Parkway. Pine-hardwood forests also cover most of the Green Spring property with loblolly pine once again the dominant species. There are several large fields along the road that splits Green Spring. At Swann's Point, one finds forested wetlands, upland forest of predominantly pines and hardwoods, with baldcypress (*Taxodium distichum*) and emergent wetlands along the shoreline. The Cheatham Pond area is restricted to military use and managed under a special use permit. The mixed hardwood-pine environment provides areas for military training, wildlife habitats, and recreational opportunities, including fishing, and boating. There are also emergent and forested wetlands associated with the pond, ravines, and shoreline.

Wetlands

Wetlands in the park include forested freshwater communities, emergent freshwater communities, and emergent tidal communities. The park's GIS inventory indicates that wetlands cover approximately 27% of the park lands. Most park wetlands are connected to larger adjacent wetland areas. Most of the rare, threatened, and endangered species found in the park are associated with one or more of these wetland types. Estuarine emergent, and palustrine emergent and forested wetlands cover almost all of Jamestown Island. Estuarine emergent intertidal wetlands are found along the James and York river shorelines and adjacent tributary creeks, including Felgates, Indian Field, Queen, King, Papermill, College, Mill, and Powhatan. Palustrine emergent and forested wetlands are associated with all the non-tidal streams in the park, along with certain sites of the parkway in the Williamsburg area, and at the sites of freshwater springs and seeps particularly in the Yorktown area. Jones Mill, Cheatham, Brackens, and Wormley pond are also home to palustrine emergent and forested wetlands. Queen's Creek is the largest estuarine emergent wetland system in York County, and is partially located inside the Cheatham Pond area



Colonial NHP

Figure 12 VEGETATIVE COVER

of the park. Yorktown Creek and its associated unnamed creek are home to a large estuarine emergent wetland. Many of the estuarine creeks within the park have been identified as nurseries for white perch *(Morone americana)*, striped bass (*Morone sazatilis*) and other species of fish. Non-tidal wetlands such as vernal pools or "seasonal wetlands" also exist within the park; however, these areas require further study to determine their correct delineations.

The park and surrounding wetland types have been inventoried over the last several decades. The U.S. Fish and Wildlife Service (USFWS) National Wetlands Inventory (NWI) program has produced maps of wetlands at a scale of 1:24,000 based on interpretation of aerial photographs, which were not ground-truth verified. The Virginia Institute of Marine Science (VIMS) has produced a detailed inventory of tidal wetlands, including the park, as part of a statewide inventory effort. The park has funded a series of projects to further map park wetlands through cooperative projects with North Carolina State University and the VIMS. Detailed digital inventories are now used in the park's GIS. The inventories are not absolute delineations of wetland boundaries based on current federal delineation guidelines, but they do represent presence and absence at a scale appropriate for planning efforts. Virginia currently is working with the USFWS to remap wetlands throughout the Commonwealth, with new maps of the park area expected to be available in hard copy and digital formats by 1995.

As part of this planning effort, existing inventories were composited and updated (Figure 13). The existing vegetation and wetlands survey for the park was also reviewed for completeness and accuracy. VIMS scientists, assisted by graduate students trained in wetland identification, conducted drive throughs and field expeditions to identify discrepancies in the current park vegetation survey. They were assisted by recent aerial photographs of the area, and GIS maps produced by the park. Potential discrepancies in the existing vegetation survey were noted in sixty-nine forested and 41 emergent field areas. Ground truthing exercises verified that of these sites 14 forested and 5 emergent areas were wetlands according to the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation, 1989). This information was translated into a new digital vegetation coverage for use in the park's GIS database.

There is not sufficient information to develop an accurate assessment of the trends in wetland resources through recent history. Qualitative assessments suggest that the park has experienced a loss of tidal wetlands (primarily due to natural processes such as erosion), while non-tidal wetlands have remained unchanged over the last several decades. This indicates that park management efforts have probably not resulted in significant losses of wetlands, although this can not be asserted with surety. The park is, however, now in the position, with a comprehensive inventory, to commence a modest periodic remapping of wetland resources. The suggested frequency is once every five years with associated change analysis to document trends and evaluate/update management strategies. The park has requested funding to conduct this remapping effort with North Carolina State University.

Fauna

As with vegetation, Colonial National Historical Park supports a diverse body of wildlife species. Park officials have recorded the presence of at least 40 mammals, 225 birds and 81 reptiles (C.D. Rafkind, Colonial NHP, personal communication). Common species of mammals in the park include squirrels, rabbits, white-tailed deer, silver and red fox, beaver, raccoons, muskrat, and opossums. Small hawks, owls, canada geese, and other waterfowl frequent the park, and bald

Colonial NHP

Wetland, forested (in-park only)

Wetland, non-forested

Shoreline, Creeks, Lakes, Ponds

Colonial NHP and Environs

Figure 13 WETLANDS

Meters

0 2000 4000

USNPS, COLONIAL NHP - GIS*MDS
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MAPFILE: D:\AGIS\DATA\WRMPF13
DATE: 07/27/94 REV: #4
CREATED BY: VIMS-CMAP, NCSU-GIS, NPS-COLO
DATE CREATED: 07/20/94

eagles have been sighted in several areas. The park is also home to several great blue heron rookeries.

Park wetlands contribute to species diversity because they support many of the park's rare species and serve as nurseries for many different species of fish. Queen Creek is the largest marsh creek in York County. Although there is some disturbance to the creek upstream, outside the park boundaries, its path through the park serves as a major fish nursery. Queen Creek and the other wetland nurseries in the area support young white perch, striped bass and spotted sea (Swihart and Spells, 1987).

In 1987, a USFWS survey of the park's Yorktown unit and Papermill Creek area of Williamsburg noted 19 species of fish in those waters which represented 15 genera and 12 families. Among the species cited were perch, sunfish, bluegill, large-mouth bass, striped bass, and spotted sea trout (Swihart and Spells, 1987).

In a 1991 study the FWS collected baseline fishery data for the Back River system in and around Jamestown Island (Swihart and Spells, 1992). The study collected fish specimens in May and October at 10 different sites within the Back River watershed. Thirty-six species of fish representing 18 families were collected. The results concluded that the Back River system served as an important nursery ground for several important commercial and recreational fishes, namely: striped bass (*Morone saxatilis*), Atlantic croaker (*Micropogonias undulatus*), American eel (*Anquilla rastrata*), summer flounder, white perch (*Morone americana*), and spot (*Leiostomus xanthurus*). Freshwater recreational fish such as largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), yellow perch (*Perca flavescens*), and sunfish were also abundant, yet the salinity regime of the habitat precludes its viability as a productive spawning ground for freshwater fish.

No federal or state listed rare, threatened, or endangered species were collected in either study. Waters in and around the park are known to support oyster beds, crabs, clams, crayfish, perch, sunfish, bluegill, and bass.

Rare, Threatened and Endangered (RTE) Species

Park officials are especially concerned with protecting any rare, threatened or endangered species. The National Park Service contracted with the Virginia Department of Conservation and Recreation, Division of Natural Heritage in 1988 to conduct a biological survey of all the NPS units in the state. According to the results of this survey, Colonial NHP has the second highest number of rare, threatened and endangered species of all the National Park Service units in the state (Commonwealth of VA., 1993)

The study identified 14 natural heritage resource element occurrences of rare plants, rare animals, and significant natural communities within the park (Table 6). Three rare plant species were identified in this inventory including: Parker's pipewort (*Eriocaulon parkeri*), small whorled pagonia (I*sotria medeoloides*, and Virginia least trillium *Tillium pusillum var virginianum*. Five rare animal species were identified including: great blue heron (*Ardea herodias*) , great egret (*Casmerodius albus*), northern spring amphipod (*Gammarus psuedolimnaeus),* bald eagle *(Haliaeutus leucocepalus*), and least bittern *Ixobrychus exilis*.

Also, the Division of Natural Heritage previously surveyed the U.S. Navy's Cheatham Annex and the adjacent Cheatham pond area of the (Commonwealth of Virginia, 1991). The survey found that the Cheatham Pond area supports a wide variety of both common and rare animals in addition to the rare

plant communities. The survey noted 8 species of turtles and 15 species of amphibians, 4 of which were salamanders. The Division of Natural Heritage identified the marl ravines around Cheatham Pond as a prime habitat for rare plants. Rare plants include Loesel's twayblade (*Liparis loeselii*) along the marl ravines, and mountain camellia (*Stewartia ovata*) in the mixed deciduous environments of Cheatham Pond. The presence of these species in the Cheatham Pond area indicates the importance of this relatively pristine environment for supporting state rare plant species.

Other inventories were conducted for the surrounding lands. The final inventory reports indicate the importance of park lands and areas adjacent to the park which serve as habitat for these and other species (Figure 14). Important natural areas were identified within and adjacent to the park at Beaverdam Creek, Brackens Pond, Cheatham Pond ravines, Cub Creek, Jamestown Island, Jones Mill Pond, Powhatan Creek, Queen Creek, and Swann's Point (Commonwealth of VA., 1989). The Division of Natural Heritage recommended that because of the importance of these areas, the park should incorporate the site boundaries and site management recommendations into park plans, which has been identified in the park's General Management Plan. These areas are significant, in part, due to their current conditions and management. Therefore, whenever any changes from current conditions or practices are anticipated by park management, the Division of Natural Heritage should be consulted for guidance and assistance in evaluation of potential impacts. As a result, this the Division of Natural Heritage has been contracted to create a detailed monitoring plan for the above park sites.

Exotic Species

The park has numerous problems of exotic noxious species including johnson grass, canadian thistle (*Carduus arvensis*), kudzu, bamboo, tree of heaven (*Ailanthus altissima*) and princess tree (*Paulonia tomentosa*). The park has been working with the State agricultural extension agents, the U.S. Soil Conservation Service, and the Colonial Soil and Water Conservation District to plan for the environmentally (and economically) sound management of the park's open fields (about 1,119 acres, 452.85 hectares). Erosion control, weed control, forestry practices, different mowing regimes, farming, and water quality have all been examined.

Also, the park has been conducting a multi-year project with the Colonial Soil Water and Conservation District to study the use of low cost selective vegetative management techniques to suppress johnson grass, without the use of herbicides. Results to date have shown a significant reduction in johnson grass. These results are based on the monitoring of the park fields and a special research plot in Yorktown.

Species of Special Interest

Colonial NHP is the location of several national champion specimen trees, including Devil's Walking Stick (*Aralia spinosa*), California privet (*Ligustrum ovalifolium*), Paper mulberry (*Broussonetia papyrifera*), and Compton Oak,(*Quercus comptoniae*), and the plant, the Yorktown Onion (*Allium ampeloprasum).*

Table 6. Natural Heritage Resources in Colonial National Historical Park			
		Number of Occurrences	
Scientific Name	Common Name	within park	outside park
PLANTS			
Carex lupuliformis	false hop sedge	0	1
Eriocaulon parkeri	Parker's pipewort	0	1
Isotria medeoloides	small whorled pogonia	0	1
Liparis loeselii	Loesel's twayblade	3	0
Listera australis	southern twayblade	1	0
Malaxis spicata	Florida adder's-mouth	1	0
Quercus shumardii	Shumard's oak	0	1
Stewartia ovata	mountain camellia	1	0
Tillandsia usneoides	Spanish moss	0	1
Trillium pusillum var virginianum	Virginia least trillium	0	1
Utricularia fibrosa	fibrous bladderwort	1	0
ANIMALS			
Ardea herodias	great blue heron	2	1
Casmerodius albus	great egret	1	0
Gammarus pseudolimnaeus	northern spring amphipod	1	0
Haliaeutus leucophalus	bald eagle	2	0
Ixobrychus exilis	least bittern	1	0
COMMUNITIES: Mid-height herbaceous estuarine wetland		0	1
TOTAL		**14**	8

Colonial NHP
Critical Habitats
Shoreline, Creeks, Lakes
RTE's

Colonial NHP and Environs

Figure 14 RARE, THREATENED and ENDANGERED SPECIES and CRITICAL HABITATS

Meters
0 2000 4000

USNPS, COLONIAL NHP – GIS•MDS
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CHAPTER 5. SUMMARY OF RECOMMENDED WATER RESOURCES MANAGEMENT PROGRAM

Introduction

The nature of the water resources within the park are such that none of them can be managed solely by consideration of features or actions within the park boundaries. Colonial NHP is spread across the coastal plain landscape in a manner which makes every part of it an element of some hydrologic system which extends beyond the park. For this reason the park's management efforts must be focused on two main objectives. The first is development of a comprehensive understanding of the structure, function and condition of its hydrologic systems. The second is effective coordination with programs managing activities outside of the park but within the watersheds which include park resources. The first objective entails development of an inventory, monitoring and research program which can advance understanding and develop status and trends information. The second objective implies action by park management to use the information gathered from the above efforts to be proactive in the protection of park resources. Park management must work closely with local, state, and federal planning and regulatory agencies to insure that actions within the park, and its watersheds, are compatible with park goals and objectives.

Table 7 summarizes suggested water resource management project statements developed as part of this planning process. Table 8 lists related project statements from the current park resource management plan (NPS, 1993b). The related project statements contain components dealing with research, inventory, monitoring, mitigation, protection, and interpretation of the aquatic environment of the park. The project statements and recommended actions are based on the need to fulfill park management goals and objectives.

Overview of Existing Activities

Colonial National Historical Park was originally established "for the preservation of the historical structures and the remains thereof for the benefit and enjoyment of the people". Through emphasis on the environment during the 1970's and 1980's, park management has recognized the need to understand and protect its significant natural resources. This new emphasis has included numerous activities over the past ten years that have developed an understanding of the importance of the extensive aquatic resources of the park and their interrelationship to the surrounding environment. Some park operational base funding, along with significant special programmatic funding and technical support, has been used to implement monitoring and research projects related to the natural environment of the park.

Some time ago, the park, developed an inventory of shoreline erosion problems. Some research on shoreline erosion control structures has been undertaken by state and federal researchers. Also, the park is working with federal, state, local, and private organizations dealing with hazardous materials spills and waste site mitigation from adjacent lands that may impact or have impacted on park resources. Additional information on park aquatic habitats and adjacent environments has been developed through the U.S. Navy's remedial investigation of hazardous waste sites adjacent to the park, and along the Yorktown section of the parkway (U.S. Navy, 1994).

Table 7. Water Resource Project Statements	
COLO-I-007.000	ADJACENT LAND USE PROTECTION ACTIVITIES
COLO-N-601.100	GROUNDWATER MONITORING
COLO-N-601.201	STATE REGULATORY PROCESS/PERMIT REVIEW
COLO-N-601.302	ESTABLISHING LAND SUBSIDENCE/CLIMATE CHANGE BASELINE
COLO-N-601.303	INVENTORY & SITE ASSESSMENT OF DRAINAGE RELATED PROBLEMS
COLO-N-601.401	DEVELOPMENT OF GEOLOGICAL MAPS
COLO-N-601.402	SHALLOW AQUIFER DELINEATION
COLO-N-601.501	INVENTORY AND MONITORING - SPRINGS, SEEPS, EPHEMERAL STREAMS, AND USTs
COLO-N-601.502	DETERMINATION OF THE FUNCTIONS & VALUES OF PARK WETLAND ENVIRONMENTS
COLO-N-601.503	SURFACE WATER QUALITY TRENDS MONITORING/ RISK ASSESSMENT
COLO-N-601.504	SHORELINE STABILITY/EROSION MONITORING

Table 8. Related Project Statements	
COLO-I-001.000	DEVELOP AND MANAGE GEOGRAPHIC INFORMATION SYSTEM
COLO-I-004.000	MANAGEMENT OF PARK GROUNDS, FIELDS, TRAILS
COLO-I-004.100	OPEN FIELDS MANAGEMENT PLANNING AND IMPLEMENTATION
COLO-I-004.200	PARK GROUNDS, FIELDS, TRAILS EROSION CONTROL
COLO-I-006.000	RESOURCE PROTECTION ACTIVITIES
COLO-I-009.000	MANAGEMENT OF RIGHTS-OF-WAY PERMITS AND SPECIAL PARK USES
COLO-I-013.000	DEVELOP FORESTRY MANAGEMENT PLAN
COLO-I-015.000	HAZARDOUS MATERIALS PLANNING -TOXICS, OIL SPILLS
COLO-N-601.000	WATER RESOURCE MANAGEMENT PLANNING
COLO-N-602.000	RTE MONITORING, MITIGATION
COLO-N-603.000	DEVELOP AND IMPLEMENT COMPREHENSIVE LONG TERM ENVIRONMENTAL MONITORING PROGRAM
COLO-N-604.000	MANAGEMENT OF NATURAL RESOURCE MANAGEMENT PROGRAM
COLO-N-606.000	DEVELOP INTERPRETATIVE EXHIBITS, HANDOUTS, SLIDE PROGRAMS
COLO-N-608.000	FAUNA INVENTORY AND MONITORING
COLO-N-609.000	FLORA INVENTORY AND MONITORING

Maintenance operation changes have been implemented for open fields and the Yorktown Bluff to improve vegetation management and reduce erosion and sedimentation problems. The park has participated in adjacent land use issues, planning, and proposals to lessen or eliminate potential impacts to park resources. In the management of the numerous rights-of-ways crossing the park, management has insured that environmental review, compliance, and mitigation has been thoroughly

followed. The park monitors its public water supplies conducting regular coliform testing, and more detailed testing in cooperation with the Virginia Department of Health and Virginia Department of Environmental Quality. Through the underground storage tank regulations (UST) the park has taken aggressive actions to test and where appropriate remove and upgrade UST's.

Research activities involving external academic/state/federal cooperators within the park has included neotropical bird surveys, limited flora and fauna surveys, and fisheries surveys, along with the recording of baseline water information. Also, a regional groundwater nutrient input study involved the Ringfield park area as a control site. Other research has developed information on the geological formation and environmental changes of Jamestown Island.

Currently a project is being undertaken, through a cooperative agreement, to characterize the potential impacts to the shallow groundwater aquifer from adjacent urban and agricultural land use activities. Other groundwater activities conducted by state and federal agencies has involved monitoring groundwater level changes and limited chemistry in selected areas of the park, as part of larger regional studies for York County and the coastal plain of Virginia. Also, a more detailed geologic survey and mapping of the park and region is continuing by the Virginia State Geologist Office.

Rare, threatened, and endangered (RTE) species and associated habitats have been identified for the park and surrounding lands. The park has contracted with the Virginia DCR, Division of Natural Heritage to develop a more detailed monitoring plan for the RTE's. Park and adjacent RTEs are closely associated with the aquatic environment. Park employees and volunteers have been recording wildlife observations.

Probably the most important inventory project the park has initiated is the development of a park based geographic information system (GIS). This has produced the first parkwide overview of the natural and cultural resources including: vegetation cover, wetlands, shoreline and drainage hydrology, floodplains, watersheds and sub-basins, soils, geology, adjacent land use, and Chesapeake Bay regulatory areas. The FY94 budget has added a full-time GIS specialist position. This will be invaluable as the GIS enters its next phase, involving expanded and more detailed inventory and monitoring, applications, modelling, and overall information management.

Currently the park has only 2 FTE's devoted to natural resource management and GIS. What has been accomplished has involved temporary and volunteer employees, cooperative cost-sharing agreements, and technical support from local, state, academic, NPS, and federal personnel. Natural resource management activities have been accomplished using numerous "soft" funding bases, along with free technical and cost-sharing assistance. The park has received excellent support through regional science and resource management, and the WASO-Water Resources Division (WRD). The park continues to pursue special programmatic "soft" funding to accomplish the objectives outlined in the Resource Management Plan (NPS, 1993b) and associated action plans, including this Water Resource Management Plan. Currently there is only sufficient funding to pay the salaries of the GIS and Natural Resource Management position, along with very limited support activities. The FY95 budget has proposed an increase to the natural resource management base to support GIS and inventory and monitoring activities. Technical assistance to address the design of surveys of drainage related problems and a multi-agency regional shallow aquifer study has been requested from WRD. Also, cost share funding has been requested to expand the park's GIS with a new five-year resurvey of vegetation, including wetlands, along with an expanded adjacent land use coverage. Technical assistance and funding for the development of a parkwide hazardous materials spill plan has been requested from the WASO-Environmental Compliance office. Additional funding from Regional

Science has been sought to complete the inventory of fisheries for park waters along the parkway and in Wormley Pond.

The recommended management activities discussed below are part of an overall programmatic approach to natural resources management.

Inventory and Monitoring

There are two elements to the aquatic inventory and monitoring program recommended for Colonial NHP. The first is establishment of park and cooperative programs to document the quantity and quality of groundwater (COLO-N-601.402, 601.100) and surface waters (COLO-N-601.503) in and adjacent to the park. Colonial NHP should undertake, in cooperation with other local, state, and federal agencies the design and implementation of sampling programs which will record the amounts of water flowing through the park and which will track the changing character of those waters (COLO-N-601.402, 601.501, 601.100). There are a number of opportunities to coordinate with existing monitoring programs, but in every case, meeting the park objectives will require modifying sampling locations or enhancing compositing of data. The routine data collection efforts should also include a commitment to periodic updates of biotic inventories (COLO-N-602.000, 608.000 and 609.000). To be able to deal effectively with concerns about drainage related problems and adjacent land use practices the park will need to undertake an inventory of current problems (COLO-N-601-.303 and 007.000).

All projects and programs proposed need to insure that appropriate GIS related databases are developed so that the information developed can be effectively managed and used. A more complete picture of the aquatic environment in, and influencing the park, will require the continued expansion of the hydrological, biological, environmental, and regulatory databases in the park's GIS (COLO-I-001.00).

Research

In order to achieve its management objectives, Colonial NHP needs to know considerably more than is currently available about the structure and function of its hydrologic systems and water dependent environments. This will require a commitment to basic descriptive studies to define the extent and behavior of shallow groundwater systems in the park (COLO-N-601.402), and geology (COLO-N-601.401). In addition to the groundwater resources, park managers will need additional information about the relationships between the park and adjacent land use practices and water quality impacts (COLO-I-007.000, I-015.000, N-601.303, 601.503), resource risks in the floodplains, wetland functions (COLO-N-601.502), and shoreline processes (COLO-N-601.504). Each of these elements is important to the long term management planning and protection of park resources. Knowledge about each of these elements will also contribute significantly to the ability of the park to influence management of lands outside the park by increasing understanding of potential impacts on park resources.

The water resources of Colonial NHP also provide some excellent opportunities for long term basic research. The conservation objectives of the park produce an area which is relatively free of unplanned and/or uncontrolled impacts on natural systems. This type of management results in systems which are very useful for analyzing the effects of processes such as climate change. In many

cases these research efforts can contribute to overall understanding of park systems, without being specifically targeted on park management issues (COLO-N-601.302).

Protection, Management and Mitigation

There are a few current conditions in aquatic resources of COLO which require mitigation or treatment. There are problems associated with drainage, which need to be corrected by the park acting independently or in cooperation with adjacent jurisdictions (COLO-N-601.303. There are localized impacts on aquatic resources associated with park maintenance practices and public use, but none appear to be of more than local significance (I-004.000). Cumulative impacts do not appear to be significant but need to be investigated. A more comprehensive approach to vegetation management including an overall forestry management plan can help insure that the cumulative impacts of park practices does not impact upon the aquatic resources of the park (COLO-I-013.000). Many of these impacts are direct consequences of supporting educational and recreational pursuits of the visiting public. Others are due to impacts from neighboring land practices including the discharge of pollutants into local streams or past practices that have developed into hazardous waste sites needing investigation and possible clean-up (COLO-I-006.000, I-015.000).

Another element in the proposed program involves monitoring of local, state and federal regulatory programs. If the park is to become effective in representing its interests to programs which manage land disturbing activities which may impact park resources, it must become a regular participant in the regulatory review process (COLO-N-601.201, I-007.000). Two things are required for success. First, the park must become fully informed about the mechanics of the programs and about the appropriate technical information. Second, the park staff must commit the time to review all the relevant planning documents, permit applications, identifying and commenting on those with significant potential impacts.

Education and Administration

An important element to the success of park resource management activities is the development of well-thought out, and publicly reviewed action plans, such as this water resource management plan. The NPS has always recognized the critical importance of environmental education. Informing the visiting and general public will not only gain needed support for park programs, but hopefully, provide an informed public the opportunity to participate in protecting the natural resources of the park, the Chesapeake Bay and nation (COLO-N-606.000). The protection and programs of the park are tied to problems of air and water pollution, biodiversity, and erosion and sedimentation problems.

The overall success of any of these activities requires the development of a comprehensive long-term environmental monitoring program as proposed in COLO-N-603.000. The park does not envision a large permanent staff, but rather, the development of cooperative and interagency agreements, contracts, and graduate student cooperative education programs to meet its research, and inventory and monitoring needs (COLO-N-604.000). This will allow the park to take advantage of the many related Chesapeake Bay related initiatives that are currently on-going. A position to coordinate overall field related activities dealing with research, and inventory and monitoring is proposed along with a part-time cooperative education graduate student. Also, additional funding would allow for the hiring of seasonal employees.

CHAPTER 6. WATER RESOURCES PROJECT STATEMENTS

PROJECT STATEMENT NUMBER: COLO-I-007

PROJECT TITLE: Adjacent Land Use Protection Activities

SERVICEWIDE ISSUE CODE: N16 TITLE: Visual and Biological Impacts of Urbanization and Other Near-Park Development on Park Resources

SERVICEWIDE ISSUE CODE: N11 TITLE: Water Quality - Ext.

PROBLEM STATEMENT

Colonial National Historical Park is located in an area undergoing steady urbanization, and private property along the park boundary is increasingly being converted from undeveloped land to residential subdivision or commercial use. Changes in land use patterns near the boundary are starting to have an adverse impact on scenic quality, with even greater threats emerging. Also, this growing population near the park results in increased pressure from recreational use of park lands, as other available open space in the area disappears. As development occurs along the park boundary, there is also increased spillover activity into the park, including adverse uses such as nonpoint source and increased storm water runoff not covered by the NPDES program, erosion and sedimentation, the dumping of refuse, boundary encroachment by adjoining landowners, illegal burning, illegal camping and fires, and illegal hunting. Recreational walking, cycling and horseback use of the park originating from adjacent residential areas result in creation of unplanned trails, which in turn have adverse impacts on natural and cultural resources.

Since the water resources within the park are largely part of watersheds which extend beyond the park boundaries, maintenance and conservation of park resources is significantly influenced by activities external to the park. The quantity of surface and groundwaters in the park is subject to greatest change in areas where adjacent land use is undergoing or susceptible to the greatest change. The east end of the park, including the Yorktown Battlefield and the Colonial Parkway along the York River, is not at significant risk currently because adjacent lands are primarily owned and managed by Newport News Water Works and the U.S. Navy. Significant changes in land use patterns on these areas is not anticipated, and much of the land is maintained in a forested condition. The west end of the park, including the parkway route from Queen's Lake westward through Williamsburg and on to Jamestown Island, is at significantly greater risk due to development of surrounding lands. Conversion of lands from forested or agricultural use to more intensive uses increases the potential for alteration of the surface water flows and groundwater levels. These changes have produced detrimental impacts on the natural and cultural resources within the park.

Additional water-related management actions resulting from adjacent land use activity (including increased nonpoint source runoff, increased erosion and sedimentation, and increased risk of contamination from discharges of fuels, sewage, chemicals and other pollutants) are addressed in project statements rights-of-ways COLO-I-009, hazardous materials COLO-I-015, water planning COLO-N-601.0, groundwater monitoring COLO-N-601.1, permit review COLO-N-601.201, drainage related problems COLO-N-601.303, and surface water monitoring COLO-N-601.503.

RECOMMENDED ACTION

Effective pursuit of park management objectives requires effective coordination with local and state regulatory and planning programs which address land use within watersheds containing park resources. Those watersheds with significant potential for change in land uses and significant park

resources should be targeted for further analysis. These analyses should compare park management objectives with potential impacts from development. This can be assisted by utilizing information now included or being entered into the park's GIS system.

At the present time, land use is directed by the comprehensive plans of York and James City counties and the city of Williamsburg. Critical local programs also include the state/local Chesapeake Bay Preservation Act regulations. The comprehensive plans address the types of development which will be considered in various watershed areas and the Chesapeake Bay Preservation Act regulations address development restrictions within certain portions of those watersheds. These plans have been researched and documented as part of the Water Resource Management Plan (Appendix 3). After an evaluation of these plans, a strategy should be designed which provides for monitoring of development in selected areas of the watershed, opportunity to coordinate the park's resource management needs with the localities, and to review and comment on local jurisdictions' comprehensive plans and guidelines for proposed projects within the watersheds. The objective should be identification of development options which will minimize adverse impacts on park resources. Subsequent to this analysis, which should be reconsidered periodically, park staff needs to monitor development proposals continuously and maintain coordination with local authorities to ensure consideration of park objectives in all permitting decisions.

The park's GIS is being used to develop a *developable lands application*, to understand those adjacent land use areas facing the greatest threat to the park's natural, cultural, and aesthetic integrity. Also, the GIS has recorded adjacent critical habitats as delineated by the Virginia Department of Natural Heritage. Digital GIS coverages for soils and drainages and adjacent land use has been created. The park is converting from the adjacent jurisdictions land use ownership records for entering into the park's GIS. The information gained from this monitoring effort will provide additional information upon which the park can build a sound and proactive cooperative management program with neighboring counties to protect the full spectrum of both NPS and local citizen objectives and values.

In addition to the GIS efforts, park management regularly attends planning commission and Board of Supervisors meetings of the surrounding counties. This regular contact provides an avenue for information exchange that is beneficial to all parties. This effort is critical to the identification of major issues and assists in soliciting cooperation by all possible concerns that may be held by local, state, and federal governments and citizens. Park, local, and regional needs are identified, and a consensus developed.

Also, additional directed patrols are needed on a regular basis along the park boundary to detect encroachment and other adverse impacts. Increased contacts with adjacent property owners to educate residents concerning park values and regulations are needed. Such educational programs can also be conducted through various property owner associations in some adjoining neighborhoods, or through an existing county newsletter. These efforts will be conducted as staffing permits, but effective actions for this project will require additional personnel. Existing cooperative efforts with other federal, state and local government agencies concerning land use planning, storm water management, and erosion and sedimentation control will continue. This project is closely tied to the need for a complete survey of the park boundary, which is identified in project statement COLO-I-024.

Also, a minimum of 1 FTE per year is needed to conduct analysis of current adjacent land use activities, the effectiveness of adjacent land use plans, review and comment on different proposals, evaluate the results of existing monitoring programs, developing and maintain regular contacts with local planning and regulatory agencies, and the incorporation of this adjacent land-use information into the park's GIS system.

COMPLIANCE

This project is categorically excluded since it involves research and monitoring only.

PROJECT STATEMENT NUMBER: COLO-N-601.1

PROJECT TITLE: Groundwater Monitoring

SERVICEWIDE ISSUE CODE:	N20	TITLE:	Lack of Basic Data
SERVICEWIDE ISSUE CODE:	N11	TITLE:	Degradation of Park Water Quality Due to External Activities

PROBLEM STATEMENT:

The park lands are surrounded by the James and York Rivers, which are part of the greater Chesapeake Bay watershed, the largest estuary in the world. Over 40 miles of the James and York River shoreline are adjacent to the park. Also, there are 24 miles of streams in the park. Over 2,482 acres of (27% of park acreage) wetlands have been delineated in the park so far. Extensive wetlands surround the park. The second highest number of rare, threatened, and endangered species, of National Park System units in Virginia, are found in Colonial NHP.

The park's surrounding communities are experiencing rapid urban growth. The information on impacts of park water quality and wetlands is limited. The park in cooperation with the Center for Management and Policy, Virginia Institute of Marine Science, has developed a *water resource management plan* to plan a comprehensive approach to park water quality, research, monitoring, and management. Park actions are being closely coordinated with other federal, state, local and university research, monitoring and mitigation activities as part of the greater Chesapeake Bay Initiative. The plan and this project directly relate to the larger Chesapeake Bay ecosystem and the various research, monitoring and mitigation programs.

Groundwater quality in regions of the Colonial National Historical Park may be currently impacted by neighboring human activities, past and present, which include: agriculture, residential development, and waste disposal in landfills. Housing construction proximal to park boundaries rapidly increased in the 1980s. More construction adjacent to the park is now in the planning stage, and similar development with potential impacts on groundwater quality in the Park can be anticipated in the future..

As required by federal and state laws and regulations, the park has been conducting long-term water quality monitoring of its drinking water systems. This monitoring has included organics, lead, and coliform testing. In conjunction with the Virginia Department of Health, Water Programs, more complete organic chemical testing is being conducted. Also, the US Public Health Service consultant for the NPS-National Capital and Mid-Atlantic Regions makes regular visits and inspections of the overall water system.

RECOMMENDED ACTION:

The park will continue with all necessary testing required by the Safe Drinking Water Act and NPS regulations (NPS-82). A longer term inventory and monitoring protocol of park watersheds is being developed with the Virginia Institute of Marine Science. A groundwater study proposal has been developed by the Virginia Institute of Marine Science and peered reviewed by the WASO-Water Resource Division. Funding has been approved and the project was initiated in July 1993. This research program is designed to inventory existing groundwater quality conditions on Colonial National Historical Park land and to provide data to permit investigation of possible correlations between water quality and land uses outside the park boundaries. Groundwater quality obtained in this program will also provide baseline information that will be necessary to identify and quantify the

human impacts on the Park that now appear unavoidable. This project will aid in developing a more complete picture of water quality information as part of the larger Chesapeake Bay initiative. The Chesapeake Bay initiative involves the EPA, USFWS, USNPS, USDASCS, and the States of Virginia, Maryland, Pennsylvania, and the District of Columbia in a long term monitoring and mitigation program.

This groundwater sampling and chemical analysis program extends and compliments VIMS' past and present research on groundwater quality in unconfined aquifers in the park and Chesapeake Bay region of the Virginia coastal plain. The anticipated cost is $42,000 and .1 FTE.

COMPLIANCE

This project is categorically excluded since it involves research only. However, to insure full compliance and the most professional product the park will continue to conduct peer reviews of all research results and recommendations. XXX clearance was received for all groundwater well locations.

PROJECT STATEMENT NUMBER: COLO-N-601.201

PROJECT TITLE: State Regulatory Process/Permit Review

SERVICEWIDE ISSUE CODE:	N11	TITLE:	Water Quality - Ext
SERVICEWIDE ISSUE CODE:	N13	TITLE:	Water Rights

PROBLEM STATEMENT:

The primary legal mechanism for Colonial National Historical Park to effectively control and monitor potential external impacts and degradation to surface and groundwater resources which flow through its landscape is the Virginia's Water Protection Permit (VWPP), which became effective in May of 1992. VWPP addresses both the use of and impacts to state waters. The Virginia Water Protection Permit Program (VWPP) regulations define "state waters" as "...all water, on the surface and under the ground, wholly or partially within or bordering the Commonwealth or within its jurisdiction" (Appendix 3). The VWPP program regulations suggest that the program is primarily focused on surface waters. The program operates in conjunction with a number of other federal and state regulatory programs (see Chapter 2). While the VWPP is not a comprehensive regulatory program, it does represent one of the means by which the park can seek to have its interests in water quantity and quality recognized and considered.

Colonial National Historical Park's interest in groundwater resources pertains primarily to the shallow aquifer which influences the health and maintenance of existing wetland resources. The Department of Environmental Quality (DEQ) has the authority to designate groundwater management areas for the principal purpose of managing withdrawals. In the coastal plain the program operates only at very small scale, covering extensive geographic areas. The DEQ utilizes information derived from a regional study of groundwater resources by the U.S. Geologic Survey and a model of groundwater aquifer recharge and yield generated in conjunction with that study. The model addresses relatively deep aquifers (those recharged in the Piedmont region and typically found at depths of 50 to 1000 feet in the COLO area) and is therefore not particularly pertinent to the surficial wetland resources within the park. Nevertheless, the authority to recognize management areas and the increasing reliance on mathematical models for guidance in review processes is significant.

In the absence of other more formal and/or effective mechanisms, participation in the public review and comment opportunities afforded by the VWPP regulations constitute one mechanism for the park to safeguard its interests in the water resources in and around the park. Other means of park participation in public review and comments includes adjacent land use protection activities discussed under COLO-I-007, and the park's legal water rights in Virginia under the doctrine of riparian water rights (see page 35). Effective representation of the park interests in groundwater resources requires that the park staff maintain a current knowledge of these regulatory developments and the permit process, as well as the ability to periodically acquire the services of hydrologists/modelling specialists who both understand model capabilities and who can provide technical assistance in permit review.

RECOMMENDED ACTION:

Since the VWPP program is new, all of the mechanics of its operation are not well developed at this time. Nevertheless, the NPS needs to become familiar with the regulations and implementation procedures of the DEQ so that it may participate effectively in the review process. As the program is presently structured, the park staff will need to undertake a continuing review of all permit applications submitted for activities within the park watersheds. The review of these applications

should occur from the perspective of potential impacts on quantity or quality of waters in the park. Preliminary coordination with DEQ staff will ensure that park input to the review process is structured for maximum value.

In addition to the continuing review of permits, the park staff, in conjunction with the National Park Service's Water Resources Division and appropriate contractors should undertake periodic evaluations of the technical information available to provide rationales for its comments to the VWPP program. These evaluations should identify the types of projects which pose the greatest threat and the nature/significance of the potential impacts on park resources. This will enable the park to submit technically supported comments and recommendations, enhancing its impact on the review process.

An initial evaluation of the technical considerations of the specific hydrologic issues, the regulatory/permitting process and park specific focus issues is expected to cost approximately $ 20,000 - $25,000. It is recommended that this evaluation be conducted externally by an appropriate cooperator/consultant. A periodic review and update of program effectiveness should be considered every three to five years.

When fully implemented, the technical consultation and permit review will require the equivalent of 0.2 FTE/year of park and/or Water Resources Division staff time. While the number and complexity of the permit reviews is likely to vary from year to year, these activities can be expected to continue for the foreseeable future.

COMPLIANCE

This project is categorically excluded since it involves research and monitoring only.

PROJECT STATEMENT NUMBER: COLO-N-601.302

PROJECT TITLE: Establishing Land Subsidence/Climate Change Baseline

SERVICEWIDE ISSUE CODE: N20 TITLE: Lack of Basic Data

PROBLEM STATEMENT:

Relative sea level in the vicinity of Colonial NHP has been rising as a result of land subsidence and increasing volumes of sea water for the past 18,000 years or more. The recent rate of change is generally estimated to be approximately one foot per century, although local rates are sometimes higher in the mid-Atlantic region. While these changes are gradual, they have the potential to affect some of the water resources of the park earlier than other areas because of the comparatively low elevations typical of much of the park lands. Climate change may accelerate the rate of sea level rise and it may also result in alteration of the amount of annual rainfall in the region. While all of these changes are subject to considerable scientific debate at present, the potential risks for park resources need to be considered in development of management plans. Increased inundation and increased rainfall may lead to changes in the character of biotic communities along the park's surface water courses. Salinities may increase along tidal reaches. Erosion may increase along both inland water courses and along exposed tidal shores. If groundwater levels rise, nontidal wetland areas may expand. While none of these changes can be predicted with certainty at present, monitoring the status and trends of both resources and relevant parameters such as relative sea level are critical for development of long-term management strategies in support of the park's conservation and interpretive goals.

RECOMMENDED ACTION:

There is no alteration of management practices which is practical or prudent in response to these processes at the current time. Nevertheless, establishing baseline conditions and monitoring change from the perspective of developing appropriate management strategies is prudent. Colonial National Historical Park should initiate cooperative efforts to monitor local sea level and climate parameters in order to develop trends assessments in support of management planning. The park should undertake initial risk assessments for water resources based on the currently available predictions for changes in sea level, temperature, rainfall and storm occurrence. The initial assessment will develop ranges of potential impacts which can be subsequently narrowed as trend information becomes available from monitoring efforts.

Establishment of basic sea level and climate monitoring programs can probably be most efficiently accomplished by establishing cooperative analytical efforts with academic and governmental entities currently involved in monitoring these parameters. (e.g. the Virginia Institute of Marine Science for sea level, the Office of the State Climatologist for climate parameters). This will require a minimum of effort and expense.

COMPLIANCE

This project is categorically excluded since it involves research only.

PROJECT STATEMENT NUMBER: COLO-N-601.303

PROJECT TITLE: Inventory and Site Assessment of Erosion and Sedimentation Related Problems

SERVICEWIDE ISSUE CODE: N20 TITLE: Lack of Basic Data
SERVICEWIDE ISSUE CODE: N12 TITLE: Alteration of Natural Flow Regimes

PROBLEM STATEMENT:

Erosion, sedimentation and associated water quality impacts have been identified as an important problem affecting park natural and cultural resources in the Colonial National Historic Park. The implementation of the Chesapeake Bay regulations in Virginia, and stronger erosion and sedimentation regulations and enforcement has highlighted problems both within and from outside the park. Natural erosion processes occur at varying but relatively slow rates in the varied natural and cultural environments of the park. But there are greatly accelerated erosion and sedimentation rates being caused by anthropogenic activities both within and outside the park that are degrading park resources. Sheet erosion is common throughout the park in the areas heavily used by visitors where visitor impacts or improper soil and vegetation management result in bare and compacted soil. Informal trails initiated by users on steep terrain and poorly designed and maintained formal trails are an important source of small gully erosion on steep hillsides. Concentrated stormwater runoff from parking lots and roadways is maintaining very high rates of erosion in gullies and stream channels at several locations. Road construction and development activities adjacent to the park has caused erosion and sedimentation problems within the park. It has the continuing potential for producing destructive erosion and/or sedimentation within the park. Bank erosion is a serious problem at several locations along the James River and York River shorelines within the park. All of these erosion processes contribute to nonpoint source pollution of the streams within and downstream of the park.

The park has aggressively dealt with special use permittees related to right-of-way grants, passing through and/or adjacent to the park, to insure minimum impact during construction and maintenance. Some requests have been denied or modified because of potential impacts. Also the park has been in consultation with local jurisdictions as they prepare storm water reviews and new plans.
As the park has identified problems it has tried to deal with them

RECOMMENDED ACTION:

Park management has taken several actions to address some of the important erosion and sedimentation problems. Changes to park mowing practices have been initiated to improve vegetative cover. More work is needed in this area. Management activities have been initiated to control the informal trails and resultant erosion on the Yorktown Bluffs (COLO-I-004.000 and 004.200. A specific project has been developed to address the shoreline erosion along the James and York Rivers (COLO-N-601.504). The park has been active dealing with adjacent land use protection activities (COLO-I-007.00). Review of proposed adjacent development proposals, rezoning cases, and coordination with local and state jurisdictions will continue, with periodic review of local and state erosion and sedimentation control and storm water management regulations.

However, the full scope of the erosion and sedimentation problems in the park is unknown as is the extent of management activities needed to address those problems is unknown. To ensure the maximum effectiveness in addressing these problems, the park needs to prepare a comprehensive inventory of erosion and sedimentation problems within and adjacent to the park. Initial inquiries

with local, state, federal authorities and university researchers could not locate any applicable procedures for quantifying these types of problems. Therefore, this project addresses the need to inventory and monitor erosion and sedimentation problems in the park and to develop specific management practices for the various types of problems. The project will: (1) develop a methodology for identifying, inventorying, and monitoring erosion and sedimentation problems, (2) apply that methodology to develop an inventory for COLO, (3) develop management practices to ameliorate the identified problems in and around the park, and (4) develop a long-term monitoring program.

Objectives of this project statement include:

1. Review and summarize the literature on erosion and sedimentation inventory and monitoring.
2. Review and summarize the federal, state, and local agencies, policies, regulations, and contacts involved in erosion and sedimentation management. Review and summarize National Park Service (NPS) policies and plans for erosion and sedimentation management.
3. Develop and document a general (quantifiable) methodology for erosion and sedimentation inventory and monitoring (ESIM) that can be utilized in a variety of national park settings, and incorporated into the park's GIS.
4. Apply the ESIM methodology in the Colonial National Historical Park (COLO) and provide to COLO an inventory with digital database and GIS maps of specific erosion and sedimentation problems, methods for long-term monitoring the problems, and recommended actions needed for amelioration of broad classes of endemic problems and specific severe problems (including associated surveys or research needed).
5. Provide a training workshop for NPS personnel on utilizing ESIM and methods for amelioration of erosion and sedimentation problems.

The proposed schedule for completion of the above objectives are:

October - December 1994: Conduct activities for objectives 1 and 2. Visit to COLO for preliminary familiarization with the park and the types of erosion and sedimentation problems. Develop preliminary outline for the ESIM approach.
January - May 1995: Continue activities for objectives 1 and 2. Visit COLO as needed to conduct an inventory of erosion and sedimentation problems. Continue work on developing ESIM.
May - August 1994: Complete objectives 1 and 2 and draft report on those objectives. Complete the inventory of erosion and sedimentation problems at COLO including recommended monitoring and ameliorative actions needed.
September - May 1995: Complete development of the full ESIM methodology and draft the ESIM document. Develop syllabus for training workshop.
June - August 1995: Conduct training workshop for NPS personnel. Draft project final report.

The proposed budget working with a cooperator from a university would involve a graduate student over two years in the preparation of the final report (and a thesis), plus technical oversight from the principal investigator\technical adviser (hydrologist\soil scientist), and consultation of a civil engineer (stormwater management). The park would provide general coordination and GIS support. Total park cost would be approximately $57,000 (39,000 for cooperator).

COMPLIANCE

This project is categorically excluded since it only involves research and monitoring. All phases of the project would be peered reviewed.

PROJECT STATEMENT NUMBER: COLO-N-601.401

PROJECT TITLE: Development of Geological Maps

SERVICEWIDE ISSUE CODE: N20 TITLE: Lack of Basic Data

PROBLEM STATEMENT:

An understanding of surface and subsurface geology of lands in and around Colonial National Historical Park is fundamental to understanding the unit's hydrology. The topography and the geologic framework controls the patterns and flow of subsurface water. The characteristics and functions of the confining units in aquifer systems are likewise defined by the geologic structure.

Numerous geologic studies have taken place throughout the Peninsula (see Chapter 3 of COLOs Water Resources Management Plan). The most recent effort to map the surface geology and stratigraphy of the area(Mixon et al., 1989) revised earlier maps, but was published at a 1:250,000 scale, which minimizes the effectiveness of the product for use in hydrologic studies and park management applications. While providing useful information, larger scale mapping is necessary in order to develop management options for water-related issues including nonpoint source and storm water runoff not covered by the NPDES program, erosion & sedimentation issues (COLO-N-601.303), groundwater monitoring (COLO-N-601.100), shallow water aquifer delineations (COLO-N-601.402), and the monitoring of springs, seeps, and ephemeral streams (COLO-N-601.501).

RECOMMENDED ACTION:

Large scale mapping of the surface geology of the park and surrounding region is being completed by Dr. R. Berquist, Office of State Geologist, assigned to the Department of Geology, College of William and Mary. This will be published at a scale of 1:24,000.

Mapped information will be transferred to a digital record for inclusion in the park's GIS database. It is expected that the park and surrounding environs will be digitized into the park's GIS through the field technical support center at North Carolina State University. The availability of digital data will fortify future hydrologic surveys.

There is no cost to the park for mapping of geologic units. The cost to digitize the final geologic maps will depend on the extent of the area digitized. It is anticipated that 0.2 FTEs and $7,000 will be required to transfer the mapped data to digital format for the park.

Compliance: The geologic mapping has received the necessary cultural XXX clearance.

PROJECT STATEMENT NUMBER: COLO-N-601.402

PROJECT TITLE: Shallow Aquifer Delineation

SERVICEWIDE ISSUE CODE: N20 TITLE: Lack of Basic Data

PROBLEM STATEMENT:

Since Colonial National Historical Park is not hydrologically isolated from any of the surrounding areas, effective management of park water resources generally requires coordination with local, state and federal regulatory programs affecting areas surrounding the park. In order to be effective in providing guidance and/or recommendations to those programs, the park must have a much better understanding of the structure and functioning of the hydrologic system in which it exists. While surface hydrology is reasonably easy to inventory and assess, the groundwater resources of the park are more difficult. The nature and extent of locally recharged aquifers which are important to nontidal wetlands and riparian resources are not currently understood. The two recent USGS reports available on this subject (Brockman and Richardson, 1992; Richardson and Brockman, 1992) address only York County, and must be expanded to focus on all park regions.

Development of this critical information requires extensive field survey efforts to define the shallow aquifers in the area. There is little currently available information addressing aquifers which are locally recharged, and these are the systems of greatest significance to park resources.

RECOMMENDED ACTION:

The delineation and characterization of shallow aquifers in the park and surrounding area is a complex undertaking given the number and extent of systems which include portions of the park. While comprehensive mapping of these systems should be an ultimate goal, the effort can reasonably be divided into park regions, with those regions under the greatest development pressure receiving first priority. This includes the area around Jamestown Island and the parkway east to the Williamsburg area. The Yorktown Battlefield and its nontidal wetland areas are a logical second priority, with the balance of the parkway a third priority. Even within these general priority areas, development pressures or funding opportunities may require selective accomplishment of the overall objective. This project should be undertaken as a cooperative regional approach involving federal (USGS), state (DEQ, State Geologist), local (county and city planning), and academic specialist.

The complexity and costs of these undertakings may vary significantly, but a preliminary estimate for a basic assessment of shallow aquifers within each of these three general park areas would cost approximately $200,000 and require approximately 2 years for completion. The solicitation of a more thorough study design and cost estimate is recommended for this project prior to Servicewide funding competition.

COMPLIANCE

This project will go through peer review of the proposal and research results, and receive XXX clearance.

PROJECT STATEMENT NUMBER: COLO-N-601.501

PROJECT TITLE: Inventory and Monitoring - Springs, Seeps, Streams, and USTs.

SERVICEWIDE ISSUE CODE:	N20	TITLE: Lack of Basic Data
SERVICEWIDE ISSUE CODE:	N11	TITLE: Water Quality - Ext

PROBLEM STATEMENT:

Colonial National Historical Park (COLO) has accomplished a reasonably complete and current inventory of surface water bodies, wetlands, and biota within the park boundaries. The U.S.D.A. Soil Conservation Service has also mapped ephemeral streams (drainages) as part of their soil survey. Missing from a comprehensive inventory of water resources in the park is more information on the location and behavior of springs and seeps and potential pollution threats to these resources. Park staff has personal knowledge of the location of most springs, seeps, and perennial, intermittent water bodies courses in the park, but this information has not been documented in the park GIS data base. There is also no long term record, quantitative or qualitative, of the behavior of these resources.

The Virginia Institute of Marine Sciences (VIMS) mapped most park shorelines and perennial streams at 1:4000 scale as part of their development of the park's Water Resources Management Plan. VIMS was not able to either procure current aerial photography for Swann's Point shoreline and creeks. Some perennial and intermittent streams (e.g. Papermill Creek, and Yorktown unit creeks) were not discernable from the imagery available. The park currently has these areas mapped at a 1:5,000 or 1:24,000 scale in the GIS.

Colonial NHP staff are aware of some of the potential pollution threats to park resources existing in the region. These include old disposal sites on the Naval Weapons Station, leaks from the Virginia fuel depot on naval lands, nonpoint source pollution arising from land uses external to the park, and the location of wells and various underground storage tanks (contents information also) on park property. While these threats are recognized, they are not currently catalogued in the park GIS database and no information on specific types or quantities of pollutants emanating from the various sources is available. Some of these activities will be reserved for later consideration.
Beneficial uses of this project include applications for inventory and monitoring wetlands, baseline information, and detection of trends in resources critical to the park conservation and interpretive objectives.

This project statement provides baseline information currently unavailable but required to conduct a thorough investigation, and in part constitutes remedial efforts to address pollution threats to park resources.

RECOMMENDED ACTION

Colonial NHP should undertake an inventory of springs, seeps, additional shorelines and streams, and underground storage tanks, wells, and septic fields on park property. Data should be mapped onto 1:24,000 scale topographic maps and digitized for entry into the park's GIS database. The inventory and GIS coverage creation may require additional aerial photography, ground-truthing, surveying using global positioning systems (GPS), and documentation of current knowledge. The project is estimated to require .4 FTE and approximately $25,000 over a four month period.

The mapped information should be used as a guide in conjunction with known potential pollution threats to springs, seeps, streams, and groundwater quality throughout the park. This information will have application to other project statements dealing with surface and groundwater (COLO-N-601.402, 601.503) and adjacent land use activities (COLO-I-007.000).

COMPLIANCE

This project is categorically excluded since it involves inventory and monitoring only.

PROJECT STATEMENT NUMBER: COLO-N-601.502

PROJECT TITLE: Determination of the Functions & Values of Park Wetland Environments

SERVICEWIDE ISSUE CODE: N20 TITLE: Lack of Basic Data

PROBLEM STATEMENT:

Colonial National Historical Park (COLO) has completed an update of its wetlands inventory. The park includes extensive tidal and nontidal wetlands and managing these systems is critical to the park's resource management objectives. Furthermore, the park's wetlands are connected to larger aquatic (and wetland) environments. In addition to knowing the location and type of wetlands within the park, effective management and compliance with state and local regulatory programs will require increased insight to the functions of these systems. Understanding the role of wetlands within the larger park system is essential to planning for future use and development of park resources. This information will be particularly critical in areas where use change is considered as the park continually reassesses its objectives for historical interpretation, conservation and public recreation. Because wetlands are integral elements in the hydrologic system of the park, and its surrounding environs, modification of hydrology or wetland structure may result in changes to other park elements. For example, clearing some wooded wetlands to provide more accurate representations of historic conditions may alter surface and groundwater conditions affecting adjacent upland communities or surface water communities. Habitat quality for selected plant or animal species may be affected and local water quality may be impacted. This is not to imply that any change would be detrimental. However, it will be essential for the park to appropriately assess all potential impacts in order to satisfy both regulatory concerns and its own management objectives.

RECOMMENDED ACTION:

The park should undertake a project to analyze the functions/values of wetlands within its boundaries. The analysis should address the multiple roles each wetland can play within the context of the park setting (habitat, water quality modifier, hydrologic modifier, aesthetic/educational, etc.). The objective should be assessment of the individual and cumulative significance of wetlands within the park. The assessment should use currently available methods and should summarize information in a format which can be used both for planning and interpretive purposes. This should include identification of hydrologic conditions and requirements of individual vegetation assemblages. This documentation will allow the park to predict potential impacts to wetlands from alterations in hydrologic regimes. Therefore, there is a strong cause/effect link between this project statement and project statement numbers drainage problems COLO-N-601.303 and inventory springs, seeps, ephemeral streams and ponds 601.501.

The existing inventories of wetlands should be used as a foundation for change detection analysis, and monitoring should be conducted periodically on a minimum cycle of once every five years. More frequent monitoring may be necessary in park areas adjacent to urban expansion projects outside the park where anthropogenic alterations in hydrology could pose a threat to wetland resources. Similarly, restoration of park lands to historic states could also constitute a change in wetland conditions, and the monitoring efforts should keep abreast of these changes. The NOAA's Coastal Change Analysis Program (CCAP), also referred to as Coastwatch, provides seasonal coverage of landuse and landcover in the Bay region. These scenes have maximum resolutions of 30 meters which limits their utility in park management applications. However, in the absence of funding

resources to monitor more frequently, CCAP data can provide gross changes in regional vegetation patterns.

Given the existing inventories of wetlands and the other information now available in the park's GIS data base, identification of the functions and values of wetland communities within the park should require approximately one year of effort, $45,000, and .1 FTE. The park is requesting special funding to conduct a five-year reevaluation of the vegetation cover of the park, including wetlands. This would be conducted under cooperative agreement(s) and would entail interpretation of new aerial photography, and ground interpretation. The cost of this project is expected to be $55,000 and .2 FTE. Regular inventory and monitoring of wetlands will require either additional park staffing or a cooperative agreement with an academic institution for employment of a graduate student. The cost of this would be approximately .25 FTE and $10,000.

COMPLIANCE

This project will receive peer review of the proposal and research results. XXX clearance will be procured.

PROJECT STATEMENT NUMBER: COLO-N-601.503

PROJECT TITLE: Surface Water Quality Trends Monitoring/Risk Assessment

SERVICEWIDE ISSUE CODE: N11 TITLE: Water Quality -Ext.
SERVICEWIDE ISSUE CODE: N20 TITLE: Lack of Basic Data

PROBLEM STATEMENT:

The quality of the surface waters within and adjacent to Colonial National Historical Park (COLO) affect the type and quality of the riparian and aquatic biotic communities which are found in the park. While there is little that the park can do in management of its lands which will significantly affect the quality of its surface water resources, it is important that COLO maintain some record of conditions to support analysis of water resource trends. Correlation of water quality changes with management practices in adjacent land areas outside the park is also extremely useful when COLO seeks to coordinate its management objectives with management programs of surrounding localities (see COLO-I-007.000).

RECOMMENDED ACTION:

There are a number of existing water quality monitoring programs throughout Tidewater Virginia (including the Department of Environmental Quality, the State Health Department and the Chesapeake Bay Program Citizen monitoring programs), but none of them currently collect samples in areas useful for monitoring impacts of adjacent land use on water quality in COLO. Nevertheless each of the programs represent an opportunity for effective collaboration and potential reduction in costs for COLO data collection efforts. The objective should be development of long term data sets which can be geo-referenced using the park's GIS. Establishing and maintaining a basic water quality monitoring program for surface waters in the park could reasonably be coordinated with groundwater monitoring programs.

The park should also undertake a water quality degradation risk assessment by looking at current and planned conditions in the watersheds which include significant park resources. A useful preliminary assessment of areas posing the greatest threats to local water quality can be developed using the potential pollutant loading calculations promulgated by the Chesapeake Bay Local Assistance Department as part of their regulatory program. These calculations are based on a model pollutant (phosphorus) and use some very generalized assumptions about the relationship between land use and pollutant loadings. Despite the generic nature of the calculations, they do provide useful guidance in planning management strategies. The park would be much more effective in representing its resource management interests in local regulatory decisions if it was armed with a site specific information base developed with the same approach employed by the local programs.

It should not be necessary to undertake these analyses in all the watersheds covering COLO holdings initially. The most critical areas are those at the western end of the park, surrounding Jamestown Island and extending east to the Williamsburg area. These are the areas under the most intense development pressure, and therefore these are the areas where change in land use and potential degradation of surface water quality is most imminent.

The surface water monitoring program might require .1 FTE, and $40,000 per year if undertaken on a seasonal basis, and coordinated with other agency programs.

The risk assessment for park watersheds would be completed by a cooperator/consultant, using information in the GIS data base and additional remote sensing information. It is projected that this one year effort would cost approximately $ 75,000 to include all sub-basins within the park.

COMPLIANCE

This project is categorically excluded since it involves research and monitoring only.

PROJECT STATEMENT NUMBER: COLO-N-601.504

PROJECT TITLE: Shoreline Stability/Erosion Monitoring

SERVICEWIDE ISSUE CODE: N20 TITLE: Lack of Basic Data

PROBLEM STATEMENT:

Colonial National Historical Park has over 40 miles of shoreline with different erosion problems. In the past, sections of the park shoreline have received erosion stabilization with seawalls, riprap, and other structures. While this has helped to stabilize these areas, in some cases (such as along Jamestown Island) these measures have caused accelerated erosion in other areas. The Virginia Institute of Marine Science (VIMS) has conducted research on shoreline erosion control within the park. Also, the Virginia Shoreline Erosion Advisory Service has provided technical advise for beach revegetation projects. The current shorelines of the park has been entered into the GIS as part of the development of the park's Water Resources Management Plan and other projects. Also, some mowing has been moved back from along the shorelines, streams, and bluffs (see park grounds, fields, trails erosion control COLO-I-004.200).

A fundamental assessment of the stability and condition of the park's shoreline is lacking. As a result, the processes and influences which have brought the shoreline to its current state are not well understood. This is of particular concern from a management perspective especially when historic, cultural, and natural resources are potentially at risk due to their proximity to the shore zone.

The most comprehensive shoreline analysis currently available for the park compares the 1850's hydrographic charts of the Coast and Geodetic Survey with the more recent topographic shoreline surveys (1950-1968) (Byrne and Anderson, 1982). The shoreline was divided into reaches which sectioned the shoreline into process similar response groups - erosional or accretional. The rate of shoreline change over the time period studied was reported on a reach by reach basis and normalized to represent erosion/accretion rates per year. Findings indicate that erosion rates along the James and York River shorelines adjacent to the park range from 0 to 1.9 ft/yr. The study, however, did not investigate shoreline conditions along the tributaries within these two principal watersheds.

In addition, the *Shoreline Situation Report for James City County, Virginia* (Hobbs et al., 1975) and the *Shoreline Situation Report for York County, Virginia* (Anderson et al., 1975) presents additional information on the condition and stability of the shore. Again, these studies targeted only the primary waterways of the Chesapeake Bay, and therefore, the tributaries contiguous to the James and York Rivers were not included.

RECOMMENDED ACTION:

The current GIS shoreline mapping activities provides a foundation that future shoreline analytical studies can build upon. In particular, the various shoreline records which have been added to the COLO GIS provides information on the stability of the shoreline over the past 20 years. Additional shoreline records are available going back as far as 100 years, Since shoreline movement is directly related to the natural wind and wave climate, available sediment supply, and human activity in the coastal zone, an assessment of these characteristics should be made to determine factors and influences most critical to shoreline stability. As well, the current shoreline records should be queried to quantitatively analyze the rate of change in shoreline position.

A comprehensive delineation and assessment of man-made structures and perturbations is recommended to provide insight into the effect artificial stabilization has had on the natural process of shoreline movement. A delineation of existing structures will determine their structural integrity and effectiveness in stabilizing the shoreline.

For the development of a shoreline management plan, the above areas of research should be investigated for all shorelines of the park. An evaluation of current and intended uses for these areas should be conducted in cooperation with this effort. Additionally, a review of current state, NPS, and federal regulatory policy regarding restrictions, use, and modifications of coastal areas will be valuable.

Based on a shoreline erosion study the park will need to institute long term monitoring, and prioritize those areas needing mitigation. NPS Management Policies and funding will be the critical factor in instituting any stabilization measures. Also, some refinements to mowing patterns along tidal wetlands, creeks, and shorelines may be needed (see COLO-I-004.200).

An initial inventory of the potential work, through a cooperative agreement, required to complete the above identified activities estimates the total project cost at approximately $100,000 and 2 years for completion. The preparation of a more thorough study plan and current project cost estimate is recommended prior to Servicewide funding competition for this project.

COMPLIANCE

This project is categorically excluded since it involves research and monitoring only. Any mitigation action will meet all environmental compliance requirements.

ENVIRONMENTAL COMPLIANCE

This Water Resources Management Plan is categorically excluded from the NEPA process. This determination is based on the guidelines provided in the United States Departmental Manual:

> 516 DM6, Appendix 7.4 B(4) - This plan would only involve nondestructive data collection, inventory, study, research, and monitoring activities.

Any activities involving disturbance to park lands will involve appropriate environmental and cultural review and compliance.

Copies of this plan have been provided to those agencies, organizations, and individuals listed under the section entitled "Copies Distributed for Review". Their review and comments on the draft report were considered in the preparation of this final Water Resource Management Plan.

REVIEW COMMENTS

Comments received were supportive of the plan and complimentary of its comprehensive and direction. Overall there were few suggested changes.

Clarification of the differences between nonpoint pollution and storm water runoff as it relates to the NPDES permit process was pointed out by the NPS-WASO-Water Resource Division and changes made throughout the text.

Dr. Dexter Havens provided a series of suggestions for design protocol as it related to the different project statements, and emphasized the need for inventory and monitoring, and support of the park's GIS efforts towards this goal.

James City County review of the plan had no comments or suggestions for improvement.

The Hampton Roads Planning District thought it was a good plan. They expressed their desire to continue the communications between the park and the planning commission, and looked forward to future opportunities to work with the park to implement this plan.

Dr. Allen Brockman, USGS, provided comments on the geology and groundwater resources subsections, which were incorporated into the final document. He stated "Your management plan exhibits careful thought and research of diverse disciplines, and you and your staff are to be commended for your organization and preparation of such a comprehensive plan for managing the park's water resources."

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